Campbell, Rich

From: Kao, Jessica
Sent: Wednesday, October 14, 2015 5:27 PM
To: Moffatt, Brett; Campbell, Rich; Kermish, Laurie; Leidy, Robert
Subject: Fwd: Redwood City Salt Ponds Jurisdictional Determination (Email 2 of 2)
Attachments: 2015.10.14 Baykeeper CCCR Ltr to EPA re Redwood City Salt Pond Exhibits 9-17.pdf; ATT00001.htm

Sent from my iPhone

Begin forwarded message:

> **From:** Erica Maharg <erica@baykeeper.org>
> **Date:** October 14, 2015 at 4:55:33 PM PDT
> **To:** <blumenfeld.jared@epa.gov>
> **Cc:** <kao.jessica@epa.gov>, "Brush, Jason" <brush.jason@epa.gov>, C/H High <howardhigh1@comcast.net>
> **Subject: Redwood City Salt Ponds Jurisdictional Determination (Email 2 of 2)**
>
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EXHIBIT 9

Baylands Ecosystem

Species and Community Profiles

Life Histories and Environmental Requirements of Key Plants, Fish and Wildlife

Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project

Baylands Ecosystem

Species and Community Profiles

Life Histories and Environmental Requirements of Key Plants, Fish and Wildlife

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Plants of San Francisco Bay Salt Ponds

Peter R. Baye

Introduction

The term "salt pond," as treated in this discussion, includes both natural and artificial large-scale persistent hypersaline ponds that are intermittently flooded with Bay water, and which occur within tidal salt marsh systems of San Francisco Bay and San Pablo Bay. Historic natural salt ponds were characterized by persistent thick accumulation of salt inundated with concentrated seawater brines. They were restricted to a relatively narrow reach of San Francisco Bay near San Lorenzo Creek. They are distinguished here from related salt marsh features such as pans and which occur at smaller spatial scales, have distinctive physiographic traits, and lack strong persistent (perennial) brines and precipitated crystaline salt deposits. Artificial salt ponds (solar salterns) are diked salt marshes which are managed for the production of concentrated brine and fractional crystallization of sea salts. Natural and artificial salt ponds are presumed to share the same narrowly adapted hypersaline biota.

Information on modern artificially engineered salt pond systems is derived principally from the biological literature on solar salterns and hypersaline environments (Javor 1989, and references within), historic documentation on the salt industry in California from the State Division of Mines (Ver Planck 1958, 1951; Dobkin and Anderson 1994) and regional documentation produced by the local salt industry and government regulatory agencies (Corps of Engineers, San Francisco District, Regulatory Branch permit and compliance files; Office of Counsel files, and references within). Information on historic salt pond systems is limited to descriptive historic accounts and descriptions, detailed topographic maps of natural salt ponds prior to extensive dike construction (U.S. Coast Survey T-charts, 1956), and field investigations by the author comparing modern salt pans, marsh ponds, and artificial salt ponds.

Environmental Setting

Salt ponds are large, shallow, hypersaline impoundments or depressions in tidal salt marsh systems which undergo a sequence of infrequent flooding with saline or brackish Bay water, evaporative concentration, and formation of strong hypersaline brines and deposits of gypsum, calcium carbonate, and crystalline salt (halite; sodium chloride).

Historic salt ponds were mapped with a high degree of resolution in the 1856 U.S. Coast Survey. They were nested within particular portions of the salt marshes along the Alameda shoreline in the vicinity of San Lorenzo Creek and Mount Eden Slough. This reach of salt marsh was distinguished by a relatively straight-edge erosional marsh shoreline, little tidal drainage at the edge of the mudflats, and evidence of drowned marsh topography (mapped as emergent sinuous tidal creek levees). The upland edge was an extensive alluvial lowland, presumably with significant subsurface groundwater discharge. No major freshwater creeks were directly associated with the salt ponds. Atwater et al. (1979) suggested that natural estuarine beach ridges along outer marsh edge were responsible for the impoundments of salt marsh that created salt ponds near San Lorenzo. Some salt ponds at the northern end of the local San Lorenzo distribution were certainly associated with well-defined barrier sand spits (U.S. Coast Survey T-charts, 1850s), which were probably nourished by sand eroded from submerged Merritt sand deposits (Pleistocene marine beach and dune). Less well-defined transgressive berms of sand and coarse organic detritus may have been deposited on top of the erosional marsh edge south of the sand spits themselves. Similar transgressive beach-marsh berms today act as dams enclosing freshwater to brackish ponds and marshes in Drake's Estero, Point Reyes and at one location in San Francisco Bay (Whittell Marsh, Point Pinole, Contra Costa County). U.S. Coast Survey T-charts also indicate numerous sandy barrier beaches which dammed (either permanently or intermittently) lagoons. The impoundment of Crystal Salt Pond by a wave-constructed swash bar or beach ridge would distinguish it morphologically, hydrologically, and topographically from more common salt marsh ponds (pans) which occurred as depressions, sometimes extensive, between tidal creeks. These were widely distributed in salt marshes in the South Bay. Extensive, elongate pans also occurred near and below the upland borders of salt marshes; these have been termed "transitional" pans, although their position and form do not necessarily indicate a gradual ecotonal relationship with alluvial or upland habitats.

Salt ponds today (solar salterns) are artificially managed and engineered diked Baylands converted from tidal salt marsh. The first artificial salt ponds began as extensions and improvements of natural salt ponds which occurred near Hayward (Crystal Salt Pond), but most of the contemporary man-made salt pond system is established in former tidal marsh that included few or no perennial hypersaline ponds. Artificial salt ponds have entirely displaced their natural forerunners; no natural true salt-crystallizing ponds remain in San Francisco Bay today, although related smaller salt pans and marsh ponds containing weak brines in summer and fall do occur.

Classification of Salt Ponds - Javor (1989) placed marine-derived hypersaline aquatic environments in four ecological salinity classes:

The first salinity class (*ca*. 60 - 100 ppt) contains a highly diverse, productive biota dominated by marine species. This class would correspond to "low salinity" ponds (a misnomer, since salinity exceeds seawater concentration), from intake ponds to the next one or two stages that support abundant macroalgae and fish.

The second class (*ca*. 100 - 140 ppt) is dominated by specially adapted halophilic species which are related to freshwater taxa, not marine taxa. The organisms include abundant cyanobacteria, unicellular green algae, brine shrimp, and various halobacteria.

The third class (*ca*. 140 - 300 ppt) is distinguished by marked reduction of species diversity (loss of cyanobacteria, most invertebrates other than brine shrimp), and dominance of *Dunaliella* and brine shrimp.

The fourth class (300 ppt to salt saturation, near 360 ppt) contains only *Dunaliella* and bacteria at low productivity.

The first class predominates in modern marsh ponds. The historic natural salt pond complex probably varied seasonally between Javor's second to fourth hypersaline classes. Other natural marsh pans were most likely predominantly in the first class only, becoming seasonally hypersaline, and supporting relatively weak brines and macroalgal cover. Natural historic salt ponds were distinguished from other types of inundated depressions in salt marshes by the persistent thick halite deposits, indicating perennial hypersaline conditions, and their large lake-like size. In these aspects, they differ from shallow marsh ponds and marsh pans, which are regularly flooded during higher spring tides, and either remain persistently ponded or develop thick algal mats which desiccate in summer (bleaching white in the sun, resembling salt deposits in aerial photographs), or only develop thin, temporary salt films on unvegetated mud and peat.

Various marsh pan features are represented in U.S. Coast Survey maps of the mid-19th century, but only a few have persisted in modern rare remnant tidal marshes, such as Petaluma Marsh, Rush Ranch and Hill Slough (Solano County). Elongate marsh ponds are evident along the upland edge of historic marshes, particularly in eastern and southern parts of San Francisco Bay. Some of these may have been influenced by surface runoff and groundwater seepage from adjacent alluvial uplands, and could have been less saline than other marsh depressions most of the year. Some historic elongate marsh edge pans may also have been the unvegetated upper intertidal surface of alluvial fans and terraces, consistent with small modern "transitional pans" observed at Hill Slough, Solano County. These also lack brine and halite development. Modern elongate marsh pans have formed in recently (100 year) prograded marshes adjacent to Mare Island dredge ponds. These ponds are about 0.3 m deep in winter and spring, and range from brackish (nearly fresh) in winter to hypersaline when ponded areas are highly reduced in summer, but no significant halite precipitation is evident in them. These and similar pans may appear white with sun-bleached dried algal mats, which resemble salt flats. High densities of true natural marsh ponds, also termed "drainage divide ponds" (owing to their position in poorly drained marsh areas between tidal creeks), also occur in the Petaluma Marsh. Marsh ponds are a variation of salt pans which are topographic depressions flooded by spring tides, and support submergent vegetation, typically macroalgae (such as *Enteromorpha* spp.) and beds of widgeon-grass (*Ruppia maritima*), indicating brackish to near-marine salinity. The beds of marsh ponds are usually a soft organic oil-like black muck composed of decayed, waterlogged organic matter.

In contrast with salt ponds in estuaries with strong marine influence, such as San Diego Bay, San Francisco Bay salt ponds are relatively nutrient-rich and sustain high primary productivity (Javor 1989). Nutrient-poor salt pond conditions promote microbial mats, while planktonic microalgae tend to dominate nutrient-rich salt pond systems (Javor 1989). Most salt ponds in San Francisco Bay support richly pigmented and somewhat turbid organic "soups" of *Dunaliella*, halobacteria, cyanobacteria, dissolved organics and organic particulates and, often in ponds between approximately 120 - 200 ppt salinity, large "blooms" of brine shrimp which graze primarily on *Dunaliella*.

Historic natural salt ponds were unlike modern artificial salt ponds in that they were not differentiated geographically into stable hypersaline classes, but varied only seasonally in salinity. Natural salt ponds went through a seasonal "intake" phase during extreme high spring tides (December-January and June-July), when Bay water flooded them and diluted them with brackish to saline Bay water, seldom exceeding 20 ppt, and typically between 2 - 10 ppt in winter. During summer-fall evaporation periods, brines formed *in situ*, ranging in salinity over time up to crystallization (saturation) near 360 ppt. In contrast, the modern engineered salt pond system is based on timed transfers of brines between ponds, resulting in spatial separation of brines at different stages of concentration, and fractional crystallization of various seawater salts (other than sodium chloride, halite), such as magnesium and potassium salts (bitterns), gypsum (calcium sulfate) and lime (calcium chloride) in different ponds. In this system, crystallization is restricted to relatively few ponds engineered to facilitate harvest of halite deposits, and relatively stable hypersalinity regimes are established for individual evaporator ponds in the system (Ver Planck 1958).

The sequential and spatial separation of brines in artificial salt pond systems also produces salt pond "types" which are not fully analogous to natural systems. The late stages of brine production near sodium chloride crystallization produce strong non-sodium brines called "bittern." Bittern brines (or bittern) are a concen-

trated solution of sodium chloride, magnesium chloride and sulfate, and potassium chloride and sulfate. The ionic balance of highly concentrated bittern is toxic even to bacteria, and saturated bittern is considered sterile (Javor 1989). During winter rains, dilute bittern stratifies on top of the concentrated bittern, and brine shrimp may appear seasonally, indicating algal production (Jim Swanson, Rick Coleman, pers. comm.). Natural salt pond brines did include bittern salts; in fact, the "low quality" of early California solar salt was due to bittern, and the modern solar saltern system is principally devised as a method to fractionate sodium and bittern salts. Crystallizer ponds, which are used to precipitate halite, are also maintained near the limits of halotolerance of *Dunaliella* (which can nonetheless fix carbon up to salt saturation; Javor 1989), but undergo seasonal dilution during winter rains.

Salt Pond Plant Community

Salt ponds support a distinctive and highly specialized halotolerant to halophilic biota consisting of microalgae, photosynthetic bacteria, and invertebrates, but no vascular plants (except along the edges of artificial salt pond levees). The dominant photosynthetic organisms of most hypersaline San Francisco Bay salt ponds are a single-celled green algal species, *Dunaliella salina* (Chlorophycophyta) and numerous species of blue-green bacteria (Cyanobacteria), halobacteria, and purple sulfur-reducing bacteria. The proportions of these organisms vary with salinity. Artificial eutrophic salt ponds with salinities closer to marine concentrations (near 35 ppt; "intake ponds") are dominated by marine macroalgae such as sea-lettuce (*Ulva* spp.), *Enteromorpha* spp., *Cladophora* spp., and also sometimes support *Fucus* spp. and *Codium* spp. where substrate is stable and firm. They also include marine diatoms, dinoflagellates, and cryptomonads. There are no detailed studies of the species diversity, distribution or geographic variation of the halophilic microflora communities of San Francisco Bay.

Managed and engineered contemporary salt ponds are ecologically similar in many respects to their natural precursor salt ponds, and presumably share the same algal and bacterial microflora.

Indicator Species - There are no detailed classifications or analytic studies of salt pond algal communities. Following Javor's (1989) classification of hypersaline environments (see Classification of Salt Ponds, above), two broad hypersaline algal communities may be identified: communities dominated by free-floating marine macroalgae typical of upper tidepools near marine salinities to low-hypersaline conditions, corresponding to intake ponds and young brines in a saltern series (e.g., *Ulva* spp., *Enteromorpha* spp., *Cladophora* spp.; also bottom-mat forming cyanobacterial colonies); and communities dominated by motile unicellular halophilic phytoplankton (principally *Dunaliella salina*), which characterize moderate to high hypersaline conditions. Macroalgal salt pond communities also correspond with fish-dominated animal communities, while phytoplankton-dominated brines are associated with brine shrimp abundance.

Bob Walker

Modern salt ponds are artificially managed and engineered diked baylands converted from tidal salt marsh. (South San Francisco Bay)

Dunaliella spp. is ubiquitous in salt ponds in San Francisco Bay. It is reported to survive, and can be photosynthetically active, in brines which are close to saturated (near 350 ppt), but may be absent in some extremely concentrated brines and bittern (potash-phase, or potassium-magnesium) brines (Javor 1989, Brock 1975). Its optimum salinity for growth is near 120 ppt, about four times the concentration of seawater. *Dunaliella salina* concentrates carotenoid and other pigments in response to various forms of physiological stress, including salinity. It can be used as a crude color-indicator of brine salinity: cells growing in 50-100 ppt are greenish, and turn yellowish-green in 150 ppt brine. Reddish hues occur in brines 200-250 ppt (Javor 1989). Purplish-red hues in brines over 200 ppt may be contributed by halophilic bacteria. A conspicuous mosaic of salt pond hues are readily visible from aerial views of San Francisco Bay, particularly in summer and fall. *Dunaliella* osmoregulates in hypersaline brines by concentrating glycerol as a compatible osmotic solute in its cytoplasm (Javor 1989).

Reference sites

There are currently no reference sites in the San Francisco Bay Estuary for true natural salt ponds (ponds which periodically or chronically produce crystalline salt deposits). The historic salt pond system near San Lorenzo Creek in Alameda was eliminated by diking in the 1850s and 1860s. All modern salt pans and marsh ponds in the Bay Area differ from these historic salt ponds. Most existing marsh ponds are only slightly hypersaline, or briefly hypersaline in late summer, and support algal mats rather than brines and halite beds. Most

existing salt pans within small modern Bay Area salt marshes are comparatively small and produce sparse and thin (few mm) salt crusts in summer and fall. In contrast, reference sites for artificial salt ponds are abundant. Examples of (relatively) low salinity intake ponds, which are saline or slightly hypersaline, are found at Pond B1/B2 in Mountain View, Pond 1 near Mowry Slough, and Pond A9 in Alviso. Examples of intermediate hypersaline ponds (known as concentrators or evaporators) are found in ponds A10-14 in Alviso, ponds 2-8 near Coyote Hills, and ponds 2-6 between Mowry Slough and Coyote Creek. High hypersaline ponds (strong brines approaching or reaching salt saturation, "pickle") are found in extensive crystallizer beds near Newark and Redwood City, ponds 10 and 26 near Newark, and periodically in drained evaporators before they are re-filled.

Modern salt marsh (and brackish marsh) pans may be found in few remnant pre-historic tidal marshes at Petaluma Marsh (abundant), China Camp (scarce) and Point Pinole (Whittell Marsh; scarce). Pans vary in topography. Some upper marsh pans are similar to patches of salt flats, while pans in middle marsh zone depressions are normally shallow ponds 10-20 cm deep. Pans which become ponded, either because of depressional topography or marsh surface drainage barriers, develop algae or widgeon-grass. Salt marsh pans also occur in historically accreted marshes at Mowry Marsh. Elongate marsh pans fringing uplands ("transitional" pans) have also formed in the relatively young (20th century) salt marsh at Emeryville Crescent and adjacent to Mare Island dredge ponds. Elongate but diffuse shore-parallel marsh pans, perhaps best regarded as incipient pans, are found along the east end of the fringing salt marsh at Highway 37. Small but well-differentiated semi-circular to semi-linear salt marsh pans occur in peaty coastal salt marshes at Limatour Spit, Point Reyes; Bolinas Lagoon; Morro Bay; Elkhorn Slough; and along Tomales Bay. Morro Bay, Bodega Bay, and Bolinas Lagoon also have elongate shallow salt marsh pans fringing alluvial deposits. Most of these salt marsh pans are brackish in winter and spring, but become moderately hypersaline (usually 40-60 ppt, rarely > 90 ppt) in summer (Baye, unpub. data) when inundated.

Historic and Modern Distribution

The historic (pre-1860) location of natural salt ponds within San Francisco Bay was probably restricted to the Alameda shoreline in the vicinity of San Lorenzo Creek (between the historic Thompsons's Landing and Union City Creek). This area included an extensive complex of both connected and isolated large ponds in a matrix of salt marsh. The complex was labelled as "Crystal Salt Pond" on the 1856 U.S. Coast Survey T-chart of the area. The San Francisco Estuary Institute estimates the acreage of Crystal Salt Pond to be approximately 1660 acres, based on the precise pond outline represented on the 1856 T-chart (R. Grossinger, personal communication). If, however, the pond size fluctuated seasonally (as expected from winter rainfall and tidal flooding), the ponded area may have been several thousand acres from late fall to spring. Two smaller ponds with similar configuration occurred north of San Lorenzo Creek, and were clearly associated with sandy barrier beach deposits at the bayward edge of the marsh. (It is not clear whether these northern satellite ponds produced high concentration brine and halite, or were merely intermittently hypersaline lagoons). Crystal salt pond was used as a salt source by aboriginal inhabitants of the Alameda shoreline, and was exploited by early Mexican, Spanish and U.S. settlers (Ver Planck 1951, 1958). Early descriptions of Crystal Salt Pond indicate that it contained a persistent crust of crystalline salt up to eight inches thick, and the brines and salt contained "impurities" of concentrated non-sodium salts ("bittern" salts, principally magnesium chloride and sulfate; Ver Planck 1958).

The natural halite deposits of Crystal Salt Pond were exhausted rapidly by the infant salt collecting industry; by 1860 they were largely depleted. Artificial enhancement of solar evaporation of brines was initiated around 1853, when salt harvesters (farmers who used salt for tanning leather and curing meats, and expanded into the salt industry) began manual construction of low berms around natural salt ponds to enhance their capacity to retain saline floodwaters and capture and precipitate their salt loads. These artificially enhanced natural salt ponds became the nucleus of the solar salt industry.

By the end of the 19th century, the salt ponds of San Francisco Bay were still confined to the northern portion of the Alameda shoreline, from San Leandro Creek to Alvarado (Union City). They did not comprise a salt pond "system," but were an aggregation of many independently owned and operated enterprises. Extensive conversion of salt marsh to salt ponds in south San Francisco Bay did not occur until the 20th century. This was facilitated by the consolidation of almost all the independent salt operations to a few (dominated by Leslie Salt Company) in the 1930s. Permit requests to the Corps of Engineers to dam numerous sloughs and marshes in the South Bay were not filed until the early 1920s. Actual levee construction would have taken at least several years, and new ponds take about 5 - 7 years to "seal" (become impermeable after gypsum and carbonate precipitation; Ver Planck 1958, Dobkin and Anderson 1994); therefore, the 1920s ponds were probably not fully functional salterns until around 1930. The last extensive marshes in the Alviso and Sunnyvale areas were not diked for conversion to salt ponds until the early 1950s (Pacific Aerial Photo archives). Bair Island was not converted to salt pond until the 1950s, although it had previously been diked for agricultural use. The modern

extent of salt ponds in the southern reaches of South Bay, therefore, is relatively recent compared with the northern Alameda salt ponds. The Napa salt ponds are even more recent: the diked Baylands of the Napa marshes were converted from derelict agriculture (seasonal subsaline to brackish wetlands) to salt ponds between 1953 and 1959. Salt production ceased there in the mid-1990s, but most of the system remains hypersaline.

Relative change - The minimum acreage of true natural salt pond in San Francisco Bay was less than 2,000 acres (SFEI 1998); the maximum acreage (assuming seasonal expansion of Crystal Salt Pond by flooding, and assuming that northern satellite ponds were brine/halite ponds) could have been on the order of 3,000 - 4,000 acres. Other marsh pan habitats were not likely to support persistent hypersaline algal communities and were presumably dominated by marine-related macroalgae or *Ruppia*, as are most salt marsh pans today. However, if a significant proportion of the historic extensive elongate lake-size marsh ponds fringing uplands (Redwood City to Palo Alto, and in the Newark vicinity) were seasonally or perennially hypersaline, the total acreage of salt pond habitat could have been on the order of 5,000 - 10,000 acres. There is very weak indication that elongate upland-fringing salt marsh pans ever contained persistent strong brines supporting the narrow hypersaline algal/bacterial community, however. Today, approximately 9,500 acres of derelict salt ponds remain in San Pablo Bay, and over 29,000 acres of artificial salt pond are actively maintained in San Francisco Bay.

Conservation Issues

Exotic Species - Salt pond microbial taxa are widespread geographically, but narrowly distributed ecologically. They are probably subject to dispersal by waterfowl and marine transport. There are no currently recognized exotic species "threats" to salt ponds as there are with vascular plants in salt marshes.

Restoration - The crude technology for creating artificial salt ponds (levee construction, wind-driven pumps, tidegates) has been well developed for over a century. There is little doubt that complete artificial salt pond systems can be created and maintained at a wide range of sizes, from as little as 20 - 50 acre historic "family size" or one-man operations (Ver Planck 1958), to the modern systems in the tens of thousands of acres. Low-salinity "intake" ponds can also be maintained independently, in the absence of a salt-producing system, by balancing influx of Bay water, residence time and re-discharge at near-marine salinity. No new salt ponds have been constructed since the 1950s, although ponds have been interconverted from one type to another since then (evaporator ponds to bittern disposal/"storage"). Small and autonomous salt pond systems could be modified to be less "productive" of salt, and more biologically "productive," by reducing the efficiency of brine and salt production. This could be achieved by increasing the flux in intake ponds, and reducing the residence time of brines in each pond transfer. In winter, when brines are diluted by rainwater, they could also be re-mixed with intake Bay water and redischarged to the Bay at near-marine salinities.

There have been recent tidal marsh restoration designs for artificial but naturalistic ponds and pans, but no marsh restoration designs have included equivalents of salt ponds. In principle, naturalistic salt ponds could be artificially created and naturally maintained by replicating the hypothetical historic conditions of Crystal Salt Pond (as inferred by Atwater 1979). This would entail deposition of coarse sediments (sand or shell hash) at the edge of a high-energy marsh shoreline, to be reworked as beach ridges which restrict marsh drainage. In theory, beach ridges would maintain form and size as they retreat with the eroding marsh edge, given ample sediment supply and overwash processes. Under less natural geomorphic settings for salt ponds, artificial naturalistic salt ponds could be created by constructing low, broad berms made of bay mud or sand that would be set at elevations enabling highest spring tides to overtop them. Low, wide berms would be less prone to gullying and breaching than steep levees, but would require some degree of maintenance. Maintenance would be minimized by setting salt pond levees within restored marshes which would shelter them from wave erosion of the open Bay. Restored naturalistic salt ponds would undergo extreme variation of salinity within and between years, depending on rainfall variation, evaporation conditions, and storm surges.

Sea Level Change and Levee Maintenance - The modern salt pond levee system requires periodic maintenance, and levees bordering the open Bay (not sheltered by fringing salt marsh) require frequent maintenance, armoring, or both. The need for levee maintenance (topping with fresh dredged sediment) is likely to become more frequent if storm frequency increases or sea level rises, as would be expected with global warming (Moffatt and Nichol and WRA 1988). Borrow pits along the interior side of salt pond levees become depleted over time, and some old borrow ditches have been widened so much that dredges need to re-handle material to bring it within reach of levees. Dredging tidal marshes as an alternative source of sediment is unlikely, since it causes conflicts with endangered species habitat. Therefore, sea level rise is likely to cause long-term increases in costs and risk of levee failure of the existing salt pond system. Sea level rise could also make naturalistic salt pond restoration more difficult, since beach ridges or low levees are more likely to breach and allow excessive (though restricted) tidal exchange to impounded areas.

Conclusions and Recommendations

The commercial salt pond operations of San Francisco Bay are unlikely to continue indefinitely because of economic changes in the Bay region and in the salt industry, and due to physical changes in the levee and borrow ditch system. Salt ponds are not likely to regenerate spontaneously as a result of natural geomorphic processes when salt marshes are restored. Other more common types of pans and ponds are unlikely to establish in young salt marshes; they are mature marsh features, associated with well-differentiated marsh topography. The environmental setting associated with salt ponds has been radically altered; the combination of steep and relatively high-energy Bay shorelines, coarse sediment supply, and extensive high salt marsh with impeded tidal drainage no longer exists. It is also likely that the feasibility of maintaining the erosion-prone levee system of the artificial salt ponds will decrease over time, as borrow ditches (sources of mud for levee repair) are depleted. Therefore, new and artificial measures will be required to conserve at least historic amounts of salt pond habitats within the Estuary in the long term. The highest priority setting for salt pond restoration of some type would be on the Alameda County shoreline, from approximately San Leandro to the Dumbarton Bridge, where the Bay shoreline profile and wave fetch may be conducive for formation of beach ridges (marsh berms), given appropriate sediment size and supply.

There is no minimal ecosystem size for salt ponds. The basic grazer food chain between *Dunaliella* and *Artemia* can be maintained in extremely small systems. However, the full microbial diversity of San Francisco Bay salt ponds, which has not been analyzed in detail, would probably not persist in small ponds. Also, since the stability of natural salt ponds is inherently low (subject to ordinary natural fluctuations as well as catastrophic changes), microbial diversity would be better conserved with a large system of semi-independent salt ponds. Pre-historic salt pond acreage was probably on the order of 2,000 acres. Aiming at this minimal acreage, in the absence of any experience at restoration of naturalistic salt ponds or "alternative" management of solar salterns, would probably be insufficient to conserve a diverse halophilic microflora.

We therefore recommend that long-term conservation of salt ponds entail the following actions:

1. Pilot projects should be undertaken that incorporate naturalistic salt pond designs as integral components of large-scale tidal marsh restoration on the northern Alameda shoreline;
2. Some existing salt ponds should be divided into smaller, autonomous units away from the open bay, preferably nested in the landward reaches of restored salt marsh areas, and managed to maintain intermediate strength brines rather than salt production;
3. Salt pond restoration and alternative management should aim for temporally variable as well as spatially variable salinity and brine depths;
4. Both artificial and naturalistic salt pond restoration should aim for designs which minimize maintenance requirements; and
5. An initial target acreage for salt ponds should reflect the uncertainty of restoring sustainable salt pond environments after commercial salt production ceases. We suggest that an initial target of approximately 10,000 acres (equivalent to late 19th century acreage) be stipulated and modified based on the results of salt pond restoration and alternative pond management.

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EXHIBIT 10

JOHN K. VAN DE KAMP
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State of California
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350 McALLISTER STREET, ROOM 6000
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July 3, 1986

Alan R. Pendleton
Executive Director
San Francisco Bay Conservation and
Development Commission
30 Van Ness Avenue
San Francisco, CA 94102-6080

Dear Mr. Pendleton:

RE: Request for an Informal Opinion regarding BCDC Salt Pond Jurisdiction

You have requested an informal letter of advice from this office regarding the San Francisco Bay Conservation and Development Commission's (BCDC) jurisdiction over salt ponds. More specifically, your questions are:

1. Do "salt ponds", as that term is used in Government Code section 66610(c), include areas known as concentrators, pickle ponds, crystallizers, bittern ponds and wash ponds, or is the term "salt ponds" limited to only concentrators?

2. Does salt pond jurisdiction under Government Code section 66610(c) include the levees that create the ponds, or is salt pond jurisdiction limited only to the water-covered areas within such ponds?

3. Are the levees that separate salt ponds from the bay shoreline and from tidal action within either or both "salt pond" and "shoreline band" jurisdiction?

4. Are ponds or portions of ponds that were created by excavating, grading or otherwise lowering areas that were not historically inundated by tidal waters, within BCDC's salt pond jurisdiction?

5. Are areas that were used only at some time during the three-year period prior to November 10, 1969 for solar evaporation of sea water "salt ponds", or is continuous, uninterrupted use for that purpose over the entire three years necessary before an area qualifies as a salt pond? 1/

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1. We received comments on these five salt pond jurisdiction questions from representatives of the Leslie Salt Company and the Shorelands Corporation. Those comments were considered in our review of this subject.

Our conclusions can be summarized as follows:

1. "Salt ponds", as that term is used in Government Code section 66610(c), include all of the various types of ponds used in salt production, including concentrators, pickle ponds, crystallizers, bittern ponds and wash ponds.

2. Salt pond jurisdiction under Government Code section 66610(c) includes the levees that surround and create the salt ponds.

3. BCDC's shoreline band jurisdiction under Government Code section 66610(b) excludes any area that is within salt pond jurisdiction under Government Code section 66610(c). Therefore, insofar as any levees are within BCDC's salt pond jurisdiction, they are not within the shoreline band.

4. The fact that salt ponds or portions of salt ponds were not historically inundated by tidal waters but were created out of upland areas does not remove them from BCDC's salt pond jurisdiction. If salt ponds created out of uplands would be subject to tidal action if the dikes and man-made obstructions were removed, then the ponds are within BCDC's salt pond jurisdiction.

5. Continuous, uninterrupted use of a salt pond for solar evaporation of water throughout the three-year period prior to November 10, 1969 is not required for a pond to be a "salt pond" within the meaning of Government Code section 66610(c). A pond qualifies as a salt pond if it was used only at some time during the three year period for the solar evaporation of water in the course of salt production. 2/

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2. This informal opinion only addresses the issue of BCDC's jurisdiction over salt ponds. The question of how that jurisdiction should be exercised in response to proposals for development of or changes in use of salt ponds involve a different subject which is not addressed herein.

I. All Types of Ponds Are Included Within The Term "Salt Ponds"

As we understand it, there are different types of ponds that are used in a salt works for the production of salt through evaporation. A brief description of the salt making process will identify and describe the functions of the various types of ponds. Salt water is initially pumped from the bay into ponds called "concentrating ponds" or "concentrators." Salt water is concentrated or becomes more saline in these ponds as a result of solar evaporation. The concentrated salt water or brine is then pumped into "pickle ponds" where it may be held for varying periods of time until it is transferred to ponds called "crystallizers" or "crystallizer ponds." The transition from liquid brine to salt occurs in the crystallizer ponds. After the concentrated brine is introduced into the crystallizer ponds, salt crystallizes and precipitates out on the floor of the crystallizer. The crystallization process is a gradual one. When a sufficient amount of salt has accumulated, the excess liquid called "bittern" is drained off into "bittern ponds." The salt is then "harvested" or collected using mechanical equipment. After harvesting, the crystallizer ponds are flushed out with bay water, which is pumped back through the salt pond system, and the crystallizer ponds are then left to dry. The bittern which was drained off from the crystallizers is stored in the bittern ponds. Some of the bittern may be treated and pumped back through the salt pond system, and some may be harvested and sold for the salts other than sodium chloride which it contains. The crystallized salt that was removed from crystallizers is washed using saturated brine taken from other salt ponds. The washing removes silt and other impurities that are picked up during the harvesting. After washing, the wash water is drained into "wash ponds" where the water is held to allow for settlement and clarification of silt and other impurities. After clarification, the wash water is put back into the salt pond system. The entire cycle for conversion of bay water to crystallized salt takes roughly four to five years.

There are certain differences and similarities which can be noted among these various types of ponds. First, the

largest amount of evaporation whereby bay water is concentrated into brine occurs in the concentrator ponds. Nonetheless, solar evaporation does occur in all of the remaining types of ponds (pickle ponds, crystallizers, bittern ponds, wash ponds). See Ver Planck, Salt in California, Cal. Division of Mines, Dept. of Natural Resources, Bulletin 175 (1958), p. 51 (noting that evaporation continues in crystallizer ponds as salt precipitates out, and that further evaporation in bittern ponds raises the specific gravity of bittern); see also Salt-Our Bond With The Sea, Leslie Salt Co., Newark, California, (undated), pp. 10-11 (diagram illustrating and partially quantifying solar evaporation from concentrating, crystallizer, pickle and bittern ponds). Moreover, evaporation is a necessary component of the crystallization process that occurs in crystallizer ponds. The amount or rate of solar evaporation that occurs in the different types of ponds varies with the salinity of the liquid and the length of time the liquid is held in the ponds, but evaporation does occur in all of the ponds.

Second, while the liquids held in ponds other than concentrators may have different names, i.e., "brine", "bittern", "wash water", all of the liquids held in these various ponds either consist of, or are derived from, seawater. The various liquids represent different stages or by-products of the seawater-to-salt conversion process.

Third, the various ponds differ as to the amount of time in which they are water-covered. Concentrator ponds are continuously filled with bay water. Pickle ponds are also filled with water most of the time. Crystallizers, in contrast, are dry land for portions of the year after the salt has been harvested and after the crystallizers have been flushed with bay water. Bitten and wash ponds may also be dry on some occassions.

Fourth, all of the ponds are integral and essential components of the salt production system. Moreover, various pond components are pumped back or "recycled" within the salt production system, such as, for example, treated bittern and clarified wash water which are put back into the salt pond system.

Given these characteristics, you have asked whether all types of ponds should be treated as "salt ponds" within the meaning of Government Code section 66610(c). More specifically, it has been contended that only concentrators should be included within the term "salt ponds", because the solar evaporation process primarily occurs in concentrators and not in the other types of ponds. It has also been suggested that because certain ponds are dry land for portions of the year and are not continuously filled with water, they do not qualify as "salt ponds."

Government Code section 66610(c) provides that BCDC has jurisdiction over:

> "salt ponds consisting of all areas which have been diked off from the bay and have been used during the three years immediately preceding the effective date of the amendment of this section during the 1969 Regular Session of the Legislature for the solar evaporation of bay water in the course of salt production." (Emphasis added).

There is nothing in section 66610(c) or the McAteer-Petris Act indicating that the term "salt ponds" was meant to exclude certain types of ponds (such as crystallizers, wash ponds, etc.) which are used in and which are an integral part of the overall salt pond system. At least one court has used the term "salt pond" with reference to a crystallizer. In Western Salt Co. v. City of Newport Beach, 271 Cal.App.2d 397 (1969), the issue was whether a saltmaking company could recover damages for contamination of a salt crop caused by rainwater runoff from an adjacent road. The particular pond involved was known as Vat H, which was specifically described in the opinion as a crystallizer. See 271 Cal.App.2d at 398 (noting that in the salt production process "concentrated ocean water [brine] is then transferred into crystallizers where salt is precipitated out of solution" and that "[n]ear Jamboree Road was a crystallizer known as Vat H"). (Emphasis added.) The court then went on to state that "[s]alt ponds such as Vat H" were enclosed with a wall. Id., (Emphasis added.) Thus, the opinion indicates that the ordinary usage of the term "salt pond" does include "crystallizers", and that

crystallizers are not commonly thought of as something entirely different or distinct from salt ponds.

Moreover, those familiar with the salt-making industry appear to refer to all (and not just some) of the different component areas of a salt production system as "ponds". See Regional Survey and Analysis of the South San Francisco Bay Area for Leslie Salt Company, Leslie Properties, Inc., Redwood City, California (1971), p. 158 (map of the salt production system of Leslie Salt Company identifying areas as "concentrating pond[s]", "pickle pond[s]", "crystallizer pond[s]", "bittern pond[s]", "wash pond[s]") (emphasis added); see also Salt in California, supra, pp. 41-56 (referring to "concentrating ponds", "crystallizing ponds", "pickle ponds", "bittern ponds", "wash ponds"). Therefore, there is nothing in the ordinary meaning of the term "salt ponds" which would appear to exclude any of the various types of ponds that are used to produce salt.

The fundamenal goal in construing statutory language is, of course, to ascertain and give effect to the Legislature's intent. Hollywood Marble Co. v. Superior Court, 157 Cal.App.3d 683, 689 (1984); County of San Mateo v. Booth, 135 Cal.App.3d 388, 396 (1982); Pennisi v. Department of Fish & Game, 97 Cal.App.3d 268, 272 (1979). In analyzing the legislative usage of a particular term "'the objective sought to be achieved by a statute as well as the evil to be prevented is of prime consideration in [the word's] interpretation, and where a word of common usage has more than one meaning, the one which will best attain the purposes of the statute should be adopted even though the ordinary meaning of the word is thereby enlarged or restricted and especially in order to avoid absurdity or to prevent injustice.'" People ex rel San Francisco Bay Conservation and Development Commission v. Town of Emeryville, 69 Cal.2d 533, 543-544 (1968), quoting People v. Asamoto, 131 Cal.App.2d 22, 29 (1955); see also Leslie Salt Co. v. San Francisco Bay Conservation and Development Commission, 153 Cal.App.3d 605, 614 (1984); Blumenfeld v. San Francisco Bay Conservation and Development Commission, 43 Cal.App.3d 50, 55 (1974). Statutory language "must be given such interpretation as will promote rather than defeat the objective of the law," Clinton v. County of Santa Cruz,

119 Cal.App.3d 927, 933 (1981); Pennisi v. Department of Fish & Game, supra, 97 Cal.App.3d at 273. In ascertaining legislative intent, one should look to not only the words used, but also the object of the legislature, the evils to be remedied, the legislative history, public policy, and contemporaneous administrative construction. Contra Costa Theatre Inc. v. Redevelopment Agency, 131 Cal.App.3d 860, 864 (1982); Clinton v. County of Santa Cruz, supra, 119 Cal.App.3d at 933; Pennisi v. Department of Fish & Game, supra, 97 Cal.App.3d at 273.

Government Code section 66602.1 provides some indication of the legislative objectives underlying BCDC's salt pond jurisdiction. See People ex rel San Francisco Bay Conservation and Development Commission v. Town of Emeryville, supra, 69 Cal.2d at 543-545 (in ascertaining objectives of McAteer-Petris Act for purposes of construing term "project", Court would look to findings and declarations in Government Code §§ 66600-66604). Section 66602.1 states the Legislature's finding and declaration that:

> "areas diked from the bay and used as salt ponds and managed wetlands are important to the bay area in that, among other things, such areas provide a wildlife habitat and a large water surface which, together with the surface of the bay, moderate the climate of the bay area and alleviate air pollution; that it is in the public interest to encourage continued maintenance and operation of the salt ponds and managed wetlands; that, if development is proposed for these areas, dedication or public purchase of some of these lands should be encouraged in order to preserve water areas; that, if any such areas are authorized to be developed and used for other purposes, the development should provide the maximum public access to the bay consistent with the proposed project and should retain the maximum amount of water surface area consistent with the proposed project."

Thus, the objectives of salt pond regulation, as reflected in section 66602.1, are to preserve large water surface areas so as to moderate bay area climate and aid air quality, preserve areas for wildlife habitat, and maintain the continued existence and use of salt ponds.

The original Bay Plan which was submitted to the Governor in January 1969, and which was approved by the Legislature when Government Code section 66610(c) was enacted, see Government Code section 66603, also provides important evidence of the objectives and purposes of salt pond jurisdiction. The Bay Plan findings on salt ponds note that salt ponds are an economically important and productive use of the waters of the Bay and that salt production is important for the Bay area chemical industry. Bay Plan, p. 27, finding b. The Bay Plan findings also indicate that salt ponds provide an important water surface area that moderates climate and prevents smog, id., finding c; that salt ponds are used as a habitat by shore birds, id., finding d; and that salt ponds provide some of the open space character of the Bay, id., finding g. The Bay Plan policies on salt ponds also reflect a legislative intent to preserve the entire salt pond system as an economically viable system. Thus, policy 1 of the Bay Plan, p. 27, stated that:

> "As long as it is economically feasible, the salt ponds should be maintained in salt production . . . In addition, the integrity of the salt production system should be respected (i.e., public agencies should not take for other projects any pond or portion of a pond that is a vital part of the production system)." (Emphasis added.)

The San Francisco Bay Plan Supplement, which consists of a summary of the background reports that were the foundation for the Bay Plan, also corroborates the above objectives and intent. The summary report on "Powers" in the Bay Plan Supplement identified a regional interest in salt ponds based on the open space character, shorebird habitat value, climate moderating, air pollution controlling, and economical and productive uses of salt ponds. See pps. 485-486. The report went on to note that "[t]he primary regional goal should be maintenance of the ponds in salt production."

Id., p. 486. Importantly, this objective of preserving salt ponds was viewed as one of preserving the entire salt pond production system as a viable operation, and not just preserving one type of pond that was part of the system. Thus, the report noted that "the integrity of the salt production system must be respected," (emphasis added), and that Leslie Salt Company, as a salt producer, "cannot be asked to surrender its ponds at random for various purposes, because this would jeopardize the production system (in which brine is pumped from one pond to another during the salt production cycle, with the ponds functioning in clusters of 4-5,000 acres)." Id., (emphasis added.) Moreover, as the above quote illustrates, the Bay Plan background reports do not appear to have drawn distinctions between concentrators, crystallizers, wash ponds, bittern ponds, etc. but instead treated all such ponds as salt ponds that are part of the salt production system. Thus, the background report on "Salt, Sand, Shells and Water" in the Bay Plan Supplement described the solar evaporation salt production process as one in which "[o]ver a period of three to four years, the brine is moved from pond to pond as it becomes more concentrated and is finally harvested by large machines." p. 102. The notion then appears to have been one of a successive series of "salt ponds" up until harvesting, rather than limiting the term "salt ponds" to only the concentrator ponds at the initial stage of the process.

The legislative objectives underlying salt pond jurisdiction lead to the conclusion that all types of ponds (i.e., concentrators, crystallizers, bittern ponds, pickle ponds and wash pond) should be deemed to be "salt ponds" for purposes of Government Code section 66610(c). Open space, water surface area, and wildlife habitat benefits are provided not only by concentrators, but also by the other

types of ponds used in the salt production system. 3/ Even though crystalizers and wash ponds may be dry land for portions of the year, they nonetheless are water-filled for other parts of the year, and therefore would serve the open space, air quality, climatic, and wildlife habitat purposes which are among the reasons for salt pond regulation. Similarly, although bittern ponds may have limited wildlife value due to the nature of the bittern contained therein, such ponds nonetheless provide a water surface area having climatic, air quality and open space benefits. Accordingly, all of the different types of ponds serve at least some of the objectives underlying salt pond jurisdiction. Given that fact and given that statutory terms must be construed to best attain the purposes of the Legislature, the term "salt ponds" should be construed to include all types of ponds in a salt production system.

In addition, a major objective which the Legislature sought to achieve by giving BCDC jurisdiction over salt ponds was the preservation and continued operation of a viable salt production system. Indeed, in order to obtain the air

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3. For example, Leslie Salt's Regional Survey and Analysis of the South San Francisco Bay Area, supra, notes that crystallizers, as well as other types of salt ponds, have wildlife habitat benefits: "Salt ponds have become important as a specialized habitat in the evolutionary development of the existing wildlife in the Bay Region. Shore birds and waterfowl of many kinds can be observed in most of the salt ponds, including crystallizers, at almost any time of the year." p. 92. Moreover, certain types of birds will congregate on "broad, barren salt flats" and "drying salt ponds." Id., quoting Delisle, Preliminary Fish and Wildlife Plan for San Francisco Bay Estuary, Cal. Dept. of Fish and Game (1966), p. 50. Some birds favor less saline ponds; others are attracted to more saline ponds which provide brine shrimp as a food source; and others use ponds shallow enough for wading irrespective of the salinity of the pond. See Anderson, A Preliminary Study of the Relationship of Saltponds and Wildlife - South San Francisco Bay, Cal. Dept. of Fish and Game (1970), p. 13.

quality, climatic, open space and wildlife habitat benefits of the continued use of concentrators, the other components of the salt pond system, such as pickle ponds, wash ponds, bittern ponds, etc. must also be preserved. The references in the Bay Plan and Bay Plan Supplement to preserving the integrity of the salt production system, the recognition that all of the various types of ponds are an interdependent and interrelated system, and the statements that this system will be jeopardized if certain ponds or portions of ponds are lost indicates that all of the component parts of the system (crystallizers, pickle ponds, bittern ponds, etc.) should be included within the term "salt ponds." If "salt ponds" were deemed to include only concentrators, then other ponds - which are essential to the continued operation of the system - could be more easily converted to other uses, which would impair the viability of the overall system. The term "salt pond" in Government Code section 66610(c) would then have been construed to defeat the Legislature's objective of preserving salt pond systems and undermine the legislative intent "to encourage continued maintenance and operation of salt ponds," Government Code section 66602.1. Because statutes must be construed to promote rather than defeat the Legislature's objectives, the term "salt ponds" should be construed to cover all types of ponds involved in the salt production process.

Such an interpretation of the term "salt pond" is clearly compatible with the language in Government Code section 66610(c). All of the various types of ponds, be they concentrators, crystallizers, bittern ponds, wash ponds or pickle ponds are "areas . . . used . . . for the solar evaporation of bay water in the course of salt production", Government Code section 66610(c), since evaporation occurs, to a greater or lesser extent in all types of ponds, 4/ and

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4. U.S. Geological Survey maps of South San Francisco identify as "salt evaporators" areas that include all types of ponds, including concentrators, crystallizers, bittern, pickle and wash ponds. Compare map of the Leslie salt production system in Regional Survey and Analysis of the South San Francisco Bay Area, supra, with USGS 7 1/2 minute quad sheets for Mountain View (1961, revised 1968); Newark (1959, revised 1968); Palo Alto (1961, revised 1968); Redwood Point (1959, revised 1968).

since the ponds are all used in the course of salt production. Moreover, the Courts have consistently interpreted the provisions of the McAteer-Petris Act broadly and liberally so as to effectuate the important public purpose of comprehensive regulation in and around the bay. See Leslie Salt Co. v. San Francisco Bay Conservation and Development Commission, supra, 153 Cal.App.3d at 616-617; Blumenfeld v. San Francisco Bay Conservation and Development Commission, supra, 43 Cal.App.3d at 56. Thus, the literal language of Government Code section 66610(c) does not preclude wash ponds, pickle ponds, bittern ponds, and crystallizers from being treated as salt ponds, and the liberal rule of construction for the McAteer-Petris Act militates in favor of including such ponds within BCDC's salt pond jurisdiction.

The Bay Plan maps themselves also corroborate the notion that all types of ponds should be included within the term "salt pond" for purposes of Government Code section 66610(c). We are informed both by the staffs of BCDC and the State Lands Commission that areas in the Bay Plan maps that are designated as "salt ponds/managed wetlands" include concentrators, pickle ponds, crystallizers and bittern ponds. We also understand that while the Bay Plan maps are not uniformly consistent in designating all wash ponds as "salt ponds" (for example, a wash pond at Redwood City was designated for future port priority use), the wash pond in the Baumberg Tract is shown on Bay Plan Map 5 as a salt pond. Thus, when the Bay Plan and accompanying maps were submitted to the Legislature in 1969, the maps indicated that all of the various types of ponds used in the salt production process were assumed to fall under the rubric of "salt ponds" and were intended to be the type of ponds that fell within BCDC's salt pond jurisdiction. In the absence of any showing that the Legislature rejected this interpretation of salt pond jurisdiction, these Bay Plan

maps confirm our interpretation of the legislative intent on this point. 5/

Finally, we note that it is not difficult to convert salt ponds from one type of use to another. For example, certain bittern ponds on the Baumberg tract have been converted to and used as concentrators and pickle ponds. See June 10, 1985 letter from Raymond Thinggaard to Steve McAdam, BCDC, p. 2; see also Dorn, Salt, Univ. of California, Berkely, Nov. 16, 1982 (unpublished manuscript), p. 22 (noting that "crystallizing ponds can easily be converted to concentrating ponds if needed.") If BCDC's salt pond jurisdiction was construed as being limited to only one type of pond (for example, concentrators), then certain areas might pass in and out of BCDC's jurisdiction depending solely upon the fortuitous production patterns of the salt-making company. We doubt that the Legislature intended to make BCDC's jurisdiction so variable and uncertain.

In sum, for all the above reasons, we conclude that BCDC's salt pond jurisdiction includes all areas known as concentrators, pickle ponds, crystallizers, bittern ponds and wash ponds.

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5. Because of their scale, the Bay Plan maps may not be conclusive as to particular jurisdictional and boundary determinations for specific pieces of property. See 14 Cal. Admin. Code. § 10180; see also Blumenfeld v. San Francisco Bay Conservation and Development Commission, supra, 43 Cal.App.3d at 56 (even though particular parcel was not shown on Bay Plan maps as within BCDC's "bay" jurisdiction, it was still found to be within that jurisdiction.) Nonetheless, the maps are sufficiently accurate to indicate, as a general matter, that all types of ponds were intended to be included within BCDC's salt pond jurisdiction. The Bay Plan maps are relied upon here not for purposes of any particular boundary determination for specific pieces of property, but rather as evidence that the Legislature was aware of and approved the inclusion of large general areas, consisting of crystallizer, pickle, wash and bittern ponds, within BCDC's salt pond jurisdiction.

II. Salt Pond Jurisdiction Includes Salt Pond Levees

There are a number of reasons why we conclude that the dikes creating salt ponds are included as part of a "salt pond" as that term is used in Government Code section 66610(c).

First, the language of section 66610(c) refers to "areas which have been diked off from the bay" and does not limit the definition of salt ponds to only "water-covered" areas interior of dikes. The statutory language, in short, is broad enough to include the protective works or dikes without which there would be no salt pond at all.

Second, because an important objective of the Legislature was to preserve and maintain a viable functioning salt pond system, it is reasonable to conclude that the Legislature intended that the dikes - which are an essential requirement for maintaining that system - should also be subject to BCDC salt pond regulation. If salt pond dikes were not within BCDC's salt pond jurisdiction and were outside the shoreline band, then any regulatory effort to maintain and preserve a viable salt pond system would be severely hampered. The statutory language should not be read as thwarting the legislative objective of preserving the salt pond system, and to read the term "salt ponds" as excluding the dikes would lead to this result.

Third, pursuant to Government Code section 66632(f), BCDC has adopted a regulation for minor repairs or improvements within the area of BCDC's jurisdiction which may be approved by administrative permit. That regulation, 14 Cal. Admin. Code section 10122(c)(2), provides that within BCDC's salt pond jurisdiction, a minor repair or improvement includes:

> "Repairs to protective works in the minimum amount necessary to stabilize existing dikes or to provide improved wildlife habitat." (Emphasis added.)

Thus, by providing that certain work on salt pond dikes constitutes a minor repair or improvement, the regulation assumes that salt pond dikes are clearly within BCDC's salt pond jurisdiction. Because interpretations of a statute by the agency charged with its administration are accorded

deference by the courts, see e.g., Western Oil and Gas Assn. v. Air Resources Board, 37 Cal.3d 502, 521 (1984), 14 Cal. Admin. Code section 10122(c)(2) buttresses our view that salt pond dikes are included within BCDC's salt pond jurisdiction.

Finally, we also understand that the Bay Plan maps that were submitted to and approved by the Legislature do not exclude salt pond dikes from the area that is identified within BCDC's salt pond jurisdiction. Thus, by approving the Bay Plan, the Legislature may be presumed to have been aware of and to have validated the view that salt pond dikes are included within BCDC's salt pond jurisdiction.

III. Salt Pond Levees Are Not Within The Shoreline Band

As indicated above, the levees that create and surround salt ponds are part of the salt ponds and fall within BCDC's salt pond jurisdiction. Insofar as such levees are within BCDC's salt pond jurisdiction, they cannot also be within BCDC's shoreline band jurisdiction. Government Code section 66610(b), which defines BCDC's shoreline band jurisdiction, states that BCDC's jurisdiction includes:

> "A shoreline band consisting of all territory located between the shoreline of San Francisco Bay as defined in subdivision (a) of this section and a line 100 feet landward of and parallel with that line but excluding any portions of such territory which are included in subdivisions (a) (c) and (d) of this section; provided that the commission may, by resolution, exclude from its area of jurisdiction any area within the shoreline band that it finds and declares is of no regional importance to the bay."
> (Emphasis added.)

Subdivision (c), which is referred to in the above provision, is the provision for salt pond jurisdiction, Government Code section 66610(c). Therefore, by the terms of Government Code section 66610(b), an area cannot be simultaneously part of a salt pond and at the same time within the shoreline band. Because salt pond levees are

within BCDC's salt pond jurisdiction, they cannot also be within the shoreline band.

IV. Salt Pond Jurisdiction Includes Ponds That May Have Been Excavated From Uplands And That Were Not Historically Part of The Bay

Two preliminary observations should be made before analyzing the scope of salt pond jurisdiction in relation to the historic configuration of the Bay.

First, BCDC's "bay" jurisdiction under the McAteer-Petris Act is not limited to that part of the bay in which the State of California has or had a sovereign title interest. The definition of the "bay" for purposes of McAteer-Petris Act land use regulation is totally independent of public-private ownership considerations and is not limited in its landward extent by any past or present locations of the "ordinary high water mark", which defines the boundary between public and private ownership. See generally Government Code section 66610(e). Instead, BCDC "bay" jurisdiction extends to all lands, regardless of the source of title, that are "subject to tidal action." See Government Code section 66610(a).

Second, we understand that most of the salt ponds around San Francisco Bay were, in fact, created out of marsh, swampy and other low-lying lands that were reached by tidal action. See, for example, Regional Survey and Analysis of the South San Francisco Bay Area, supra, p. 16, ("for the most part, the salt ponds occupy former salt water marshland"). These marsh lands were then diked off, drained and used for salt making purposes. Salt ponds were created out of marsh and other flooded areas rather than dry uplands, because it was extremely costly and uneconomic to use for salt making purposes uplands suitable for valuable farming and other land uses. The cost of excavating uplands not reached by bay waters and the expense of having to pump brine to higher elevations discouraged use of uplands for salt making, particularly when there were vast tracts of marsh and bay lands at lower elevations that were readily available.

Thus, in most cases, present day salt ponds are in fact located on marsh lands that were historically subject to tidal action. To that extent, the issue of whether BCDC's salt pond jurisdiction extends to salt ponds excavated out of dry uplands may be a moot issue in most cases since salt ponds appear to have been largely created out of marshy baylands rather than dry uplands. However, there may be a few rare exceptions where salt ponds were excavated out of uplands.

Assuming that is the case, the question whether salt pond jurisdiction includes ponds that may have been created out of uplands requires interpretation of Government Code section 66610(c). That provision refers to salt ponds as areas "which have been diked off from the bay." (Emphasis added.) On the one hand, this language could be read as meaning that the land area constituting the salt pond must have originally been part of the bay. On the other hand, given that the verb "dike" means simply "to surround or protect with a dike", Webster's New International Dictionary, 2d Ed., p. 730, the language could be read as meaning that salt pond jurisdiction includes all areas that are protected by dikes and would be touched by bay waters if the dikes were removed and the area restored to tidal conditions. Under this latter view, it is irrelevant whether the area occupied by the salt pond was or was not historically part of the bay so long as the area is protected by dikes and would be subject to tidal action if the dikes or man-made obstructions were removed.

We believe that the second interpretation of the statutory language is the better one for a number of reasons. First, Government Code section 66602.1 and the Bay Plan policies on salt ponds indicate that the Legislature wanted to include salt ponds within the scope of the McAteer-Petris Act because salt ponds provide a large water surface area which has climatic and air quality benefits, and because such ponds provide a wildlife habitat and open space. These benefits are provided regardless of whether the area occupied by the salt pond was historically part of the bay. Salt ponds that may have been created by excavating or grading upland areas are just as beneficial, in terms of providing a large water surface area for climatic and air quality benefits and wildlife habitat and open space, as

salt ponds that were historically part of the bay. Therefore, to limit salt ponds to only those areas that were historically part of the bay would undermine the legislative objectives in creating salt pond jurisdiction in the first place.

Second, the 1969 Bay Plan indicates that if salt ponds are developed, efforts should be made to acquire salt pond areas and "breach the existing dikes, and reopen these areas to the Bay," because "opening ponds . . . to the Bay represents man's last substantial opportunity to enlarge the Bay rather than shrink it." Policy 2, p. 27. The ability to add salt pond water surface area to the bay by breaching the dikes does not depend on whether the salt ponds were historically part of the bay, or were excavated out of uplands. Both types of salt ponds are equally capable of being flooded and added to the bay, given the right elevations. Thus, the reference to areas "diked off from the bay" in Gov. Code section 66610(c) can be construed as referring not to the past origins of salt ponds as having been historically part of the bay, but rather as referring to the potential or capability of adding such ponds to the bay by breaching salt pond dikes.

Third, in Blumenfeld v. San Francisco Bay Conservation and Development Commission, supra, 43 Cal.App.3d 50, 54-57, the Court rejected the contention that BCDC's "bay" jurisdiction under Government Code section 66610(a) was limited solely to areas subject to "natural" tidal action and did not include areas subject to tidal action as a result of man-made structural modifications. Instead, the Court found that areas that were subject to tidal action by virtue of man-made structures were within BCDC's bay jurisdiction. Similarly, BCDC's regulation on areas "subject to tidal action", 14 Cal.Admin. Code section 10132, does not freeze bay jurisdiction to areas that were historically part of the bay at one given time, but includes all areas that subsequently become touched by tidal waters after 1965 (with certain exceptions not relevant here), including areas touched by tidal waters as a result of upland excavations and grading. Although Blumenfeld and 14 Cal.Admin. Code section 10132 apply to "bay" and not "salt pond" jurisdiction, they nonetheless support by analogy the

proposition that salt pond jurisdiction is not limited to, or coterminous with the historic "natural" bay shoreline, but can include upland areas that have been converted to salt pond usage.

Finally, to construe BCDC jurisdiction as limited to only those salt pond areas that are within the historic Bay margin could well lead to bizarre and anomalous consequences. For example, if a salt pond was partly within and partly outside the historic Bay margin, and if BCDC jurisdiction included only that portion within the historic Bay margin, then BCDC jurisdiction would extend in a crazy quilt fashion over portions of the pond even though both portions of the pond provide the same wildlife, climatic, air quality, and open space benefits which are the very reasons for salt pond jurisdiction. We know of no rational explanation why the Legislature would have wanted to treat different portions of the same salt pond (or salt pond system) so differently.

Moreover, if that portion of a pond that extends beyond the historic Bay margin was deemed to be outside BCDC's jurisdiction and could consequently be filled and removed from salt pond use without any regulation, then the remaining pond area might be too small to be efficient and might also be converted to uses other than salt production. Thus, such a narrow construction of BCDC's salt pond jurisdiction could well undermine the legislative intent to preserve the complete salt production system as a functioning, efficient system. We doubt that the Legislature would have sought to encourage the continued maintenance and operation of salt ponds, and then adopt a definition of BCDC's salt pond jurisdiction which thwarted attainment of that very objective.

V. Salt Ponds Used Only At Some Time During The Prescribed Three-Year Period Satisfy The Statutory Requirement For Salt Pond Jurisdiction

Government Code section 66610(c) provides, in part, that salt ponds are those areas which "have been used during the three

years immediately preceding the effective date of the amendment of this section during the 1969 Regular Session of the Legislature." (Emphasis added.)

On the one hand, the phrase "used during" the three year period could mean that salt ponds must have been continuously used throughout the entire three year period before they fall within BCDC's salt pond jurisdiction. On the other hand, the phrase could simply mean that salt ponds need only have been used at some time during the three year period. Because the word "during" may mean either "throughout the entire time of" or "at some point in the entire time of", see Webster's New World Dictionary, 2d Ed., p. 434, the plain meaning of the word "during" does not answer this question. We believe, however, that the latter interpretation is the proper one and that a salt pond need only have been used at some time during the three year period for BCDC jurisdiction to attach.

First, the very nature of the salt production system is such that certain ponds are not continuously in use even though they are essential parts of a functioning salt pond system. Crystallizers, for example, are not continuously in use. Instead, they are flooded with brine in the Spring and the salt that crystallizes out is harvested in the Fall before the rains arrive. After harvesting, crystallizers are left in a dry, unused state until the next Spring. We must assume that the Legislature was familiar with some of the basic salt production processes and that it consequently knew that certain types of ponds are left unused for substantial periods of time. If a requirement for salt pond jurisdiction is that a pond be continuously in use, then crystallizers would be excluded from salt pond jurisdiction even though crystallizer ponds are an essential element of any functioning salt production system without which no salt could be extracted. Given the Legislature's intent to preserve the continued operation of a viable functioning salt production system, it would have made no sense for the Legislature to adopt a salt pond definition which excluded one of the crucial elements of that system. In short, reading a continuous use requirement into the statute could lead to absurd results that would undermine the legislative objectives underlying salt pond jurisdiction.

Second, a continuous use requirement would permit the facile evasion of BCDC regulation of salt ponds. For example, while the proposed BCDC legislation was pending in the Legislature, salt producers could have easily drained and pulled some ponds out of production in order to claim that the ponds were not continously used throughout the specified three year period. That technique would allow salt producers to completely escape any regulation of salt ponds. We cannot believe that the Legislature sought to promote BCDC regulation of salt ponds for a variety of important public purposes, and then adopted a "continuous use" requirement which allowed such regulation to be so easily defeated. Instead, the more reasonable interpretation is that the Legislature, knowing that certain salt ponds may not have been in continuous use, sought to preclude evasion of BCDC regulation by providing that such regulation would apply if a salt pond had been used at any time (or "during") a broader three year period. Rather than specifying that salt ponds must have been used on the specific date the Act became effective (which would allow easy evasion by simply stopping production or use on that date), the Legislature provided that if any use had occurred during a three year period, the ponds should be deemed operational and subject to regulation. If ponds had not been used at all during the entire three year period, then presumably the Legislature may have felt that a salt pond had been completely abandoned and should not be subject to regulation. Because statutes should be given an interpretation "which upon application will result in wise policy rather than mischief or absurdity," De Young v. City of San Diego, 147 Cal.App.3d 11, 18 (1983), and because a continuous use requirement would lead to enormous problems of evasion and mischief, we cannot accept such an interpretation of section 66610(c).

Finally, Clinton v. County of Santa Cruz, 119 Cal.App.3d 927 (1981) also supports the view that the salt pond use requirement can be broadly construed. In Clinton, the issue was whether the forestry zoning requirement that forest land be "maintained for eventual harvest" meant that the landowner must have intended to affirmatively and actively manage the land for commercial timber production, or whether the land need only be capable of being used for commercial

forestry. The Court held that the latter interpretation of the phrase "maintained for eventual harvest" should apply, because to read into the statute the more stringent requirement of subjective landowner intent and a prior "active use" requirement would undermine the legislative intent to protect forest lands. 119 Cal.App.3d at 934-935. Similarly here, the legislative intent to preserve salt ponds whenever possible, and the remedial character of BCDC legislation lead to the conclusion that the use requirement in Government Code section 66610(c) should be liberally construed as requiring use only during some portion of the 3 year period.

VI. Conclusion

In conclusion, it is our view that BCDC's salt pond jurisdiction under Government Code section 66610(c) includes all types of ponds involved in salt production, such as concentrators, pickle ponds, crystallizers, bittern ponds and wash ponds. We also conclude that salt pond jurisdiction includes the levees that create and surround such ponds, and that any salt ponds that may have been excavated out of lands that were historically above the line of bay tidal action are included within BCDC's salt pond jurisdiction. To qualify as a salt pond, a pond need not have been continuously in use throughout the three year period identified in Government Code section 66610(c), but should have been in use for some time during the three year period. Finally, if a levee falls within BCDC's salt pond jurisdiction, it cannot be simultaneously part of the shoreline band.

Very truly yours,

JOHN K. VAN DE KAMP,
Attorney General

Linus Masouredis

LINUS MASOUREDIS
Deputy Attorney General

cc: N. Gregory Taylor, AAG, L.A.

EXHIBIT 11

Posted on Thu, Jun. 01, 2006

Cargill fined by state over toxic spill into bay

By Paul Rogers
Mercury News

State water officials have fined Cargill Salt $71,000 after the Newark company spilled thousands of gallons of toxic brine last year along the eastern shore of San Francisco Bay.

The spill occurred on June 1, from a railroad tank car parked near the Newark Barge Canal, an inlet south of the Dumbarton Bridge near Cargill's headquarters.

The substance spilled was bittern, a toxic byproduct of salt-making that is up to 10 times as salty as the ocean and harmful to fish, shrimp and other aquatic life. Bittern is used to reduce dust on dirt roads and to de-ice roads.

State officials who responded after Cargill reported the incident said they did not see floating fish or other evidence of ecological damage in surrounding marshes. However, bittern is heavier than water and can sink to the bottom, affecting species there, water quality experts have said.

Cargill, an agribusiness giant based in Minneapolis, uses large evaporation ponds ringing the bay to produce thousands of tons of salt a year for food, medicine and road de-icer.

The incident was Cargill's fourth bittern spill into the bay since 2000.

Last week, the company was notified of the fine by Bruce Wolfe, executive officer for the San Francisco Bay Regional Water Quality Control Board in Oakland.

``I think the incident was significant, but not extremely damaging,'' Wolfe said Wednesday.

``We were more concerned that the procedures Cargill had in place were not adequate. This was preventable. In general, Cargill's procedures are quite good, but this is an area they should improve.''

The water board's investigation found that a Cargill employee, thinking a railroad car was empty, opened a valve on the bottom of the car parked on tracks near the bay.

In fact, the car was full of bittern. Hardened salt that had blocked the opening dislodged, and 17,650 gallons spilled. Some was captured in a containment basin, but 7,100 gallons poured into Barge Canal, which flows into Newark Slough and San Francisco Bay.

Tests that day showed the marsh had salinity levels 13 times the normal level of the saltiest bay waters. For five days after, samples in the area showed unusually high levels of salinity.

Calls to Cargill spokeswoman Lori Johnson were not returned Wednesday.

The company has three options: Pay the fine, appeal it at the water board's July 12 meeting or fund an environmental restoration project somewhere in the bay for up to $43,000, paying the rest of the fine in cash.

Environmentalists said the fine is a good start.

``It's about time that the regional board is actually fining Cargill,'' said Sejal Chokski, director of the San Francisco Bay program Baykeeper, an environmental group based in San Francisco. ``It makes sense for them to start enforcing the law.''

The water board did not take enforcement action after Cargill's other three bittern spills. In September 2002, the company spilled 36,900 gallons of bittern into the bay at Newark and faced potential fines of more than $300,000. Several commercial fishermen in Alviso reported that shrimp catches were reduced for months after.

Why didn't the state fine Cargill then?

Wolfe said Wednesday that the investigation went off track when the two staff members assigned to the case departed. Because of state budget cuts, his agency has shrunk from 143 employees to 119 since 2001, he said. Also, state Fish and Game officials did not take water samples in 2002 immediately after the incident, so there was incomplete evidence.

Cargill also had a bittern spill on April 17, 2004, according to state records. That spill occurred from a cracked pipe on the company's facility at the Port of Redwood City; an unknown amount of bittern went into the storm drain there.

The company also spilled 1,000 gallons of bittern in 2000 from a rail car in Newark that was vandalized.

Cargill gained national attention in 2003 when it sold 16,500 acres of South Bay ponds to the state and federal government

for $100 million to restore as wetlands for wildlife. Cargill continues to make salt on 11,000 acres in the East Bay.

Contact Paul Rogers at progers@mercurynews.com or (408) 920-5045.

Posted on Thu, Jun. 01, 2006

WHAT HAPPENS NEXT

Cargill's has been fined $71,000 by state water officials for spilling toxic brine into San Francisco Bay last year. Its options:

- Pay the fine
- Appeal the fine
- Fund an environ-

mental restoration project in the bay up to $43,000 and pay the rest in cash.

EXHIBIT 12

SAN FRANCISCO BAY NATIONAL WILDLIFE REFUGE

Fremont, California

ANNUAL NARRATIVE REPORT

Calendar Year 1988

U.S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM

INTRODUCTION

San Francisco Bay has long been regarded as a gateway to America. So it is fitting that the San Francisco Bay National Wildlife Refuge (NWR) plays that same role as a "gateway" to the U.S. Fish and Wildlife Service programs and the 430+ units of the National Wildlife Refuge System.

In 1972, Public Law 92-330 provided for the establishment of San Francisco Bay National Wildlife Refuge for the preservation and protection of critical habitat and associated wildlife, migratory waterfowl and to provide an opportunity for wildlife-oriented recreation and nature study. San Francisco Bay National Wildlife Refuge encompasses approximately 19,000 acres in San Mateo, Alameda and Santa Clara counties, California at the southern end of San Francisco Bay. San Francisco Bay is one of the largest estuaries in the nation, approximately 55 miles long and 3 to 12 miles wide.

Under an agreement between the Leslie Salt Company and the Service when the refuge was established, approximately 12,500 acres remain as active salt evaporation ponds. The remaining habitat consists of salt marshes, upland, tidal mudflats and open water.

This variety of habitat supports a large number of wildlife, including 5 endangered species. San Francisco Bay is a key wintering area for diving ducks along the Pacific Flyway; the south bay is used primarily by scaup, surf scoters and ruddy ducks. The south bay wetlands support hundreds of thousands of shorebirds along with the largest wading bird rookery located in the bay.

Marine mammals also utilize the open water and sloughs. A major harbor seal haul out site is located in Mowry Slough.

San Francisco Bay National Wildlife Refuge is surrounded by an urban population of 5 million people. In spite of the potential impacts of encroaching development, plans are to complete acquisition of the approved 23,000 acres. In 1988, a legislative bill increased the authorized acreage to 43,000, greatly increasing the potential for refuge expansion.

The Refuge is a place to learn about the Bay environment through exhibits and naturalist programs; to observe and photograph wildlife; to hike, hunt and fish; and to enjoy some precious open space in the heart of a great metropolitan area.

Included in the San Francisco Bay NWR Complex are eight coastal refuges, stretching from Monterey Bay to the Oregon border. This complex is a unique combination of habitats and wildlife species. The San Francisco Bay NWR in the south Bay has tidal marshes and salt ponds. At the north end of the Bay is the San Pablo Bay NWR with estuarine and upland habitat. The Farallon Island NWR, which lies thirty miles off the coast from the Golden Gate Bridge, is comprised of high rocky islands frequented by a host of seabirds and seals. A quiet upland habitat for the endangered Santa Cruz long-toed salamander can be found at the Ellicott Slough NWR just south of Santa Cruz. The Salinas River Wildlife Management Area just north of Monterey encompasses an area of pristine beach, dunes and lagoon habitat. Found in the small pockets of native habitat at Antioch Dunes NWR are the Antioch Dunes evening primrose, Contra Costa wallflower and the Lange's Metalmark butterfly. North of the Bay area are the estuarine and tidal flats of Humboldt Bay NWR. Finally, the off-shore island, Castle Rock NWR offers a home for the endangered Aleutian Canada Goose, seabirds and seals.

INTRODUCTION Page

G. WILDLIFE

H. PUBLIC USE

I. EQUIPMENT AND FACILITIES

J. OTHER ITEMS

K. FEEDBACK.....NTR

A. HIGHLIGHTS

On October 28, 1988, Congress passed Public Law 100-556, which increased the Service's acquisition authority from 23,000 acres to 43,000 for San Francisco Bay NWR. Congress provided $3.75 million in FY 90 for acquisition (C.1). Refuge staff assisted with a new cooperative shorebird study initiated by the Point Reyes Bird Observatory; over 800,000 shorebirds were counted in San Francisco Bay in April (D.5).

The refuge received $105,000 in FY 88 to conduct the third year of the contaminant monitoring study, which ended up including a study on a major oil spill in the North Bay (D.5).

Substantial progress was made on the restoration of Tract 102 (former salt crystallizer ponds) by improving tidal circulation (F.2).

Cooperative surveys by refuge and State biologists of the endangered California clapper rail indicated that the population may be much smaller (500-1,000 birds) than previously estimated (G.2).

An environmental education program, similar to the one used at the Environmental Education Center, was initiated at the headquarters in Fremont (H.2).

The refuge cooperating association completed its first full year and brought in receipts of $33,000 (H.18).

Refuge and Regional Office staff remodeled the Visitor Center to accommodate new interpretive displays (I.2).

Our former brine shrimp harvest contractor sued the Service in 1988, following the award of a 5-year contract to a new contractor in 1987 (J.2).

B. CLIMATIC CONDITIONS

In a normal year, the Bay area has a modified Mediterranean climate with warm to hot, dry summers and moist, mild winters. Ninety percent of our rainfall occurs in the late fall and winter months with January being the wettest. Normal annual rainfall amounts vary according to local topography. In the South Bay 16-20 inches is normal while some areas in the North Bay receive more than 45 inches.

The fall and winter of 1988 had below normal rainfall with November and December being very cold. The summer was very warm in comparison to past years.

C. LAND ACQUISITION

1. Fee Title

Several more small tracts (1/8-1/4 acre) were purchased within the Alviso and Mowry Units during the year. We still have a number of sites remaining to be purchased at "Drawbridge" and in the "New Chicago Marsh" area of the Alviso Unit. The ability of our realty people to locate missing owners and the availability of funds will determine the length of time required to complete these purchases.

3. Other

In March 1988, California Congressman Don Edwards introduced legislation (H.R. 4272) in an effort to enlarge the refuge. On October 28, 1988, Congress passed Public Law 100-556 which increased the Service's acquisition authority from 23, 000 acres to a total of 43,000 acres. Congress also provided $3.75 million for acquisition in Fiscal Year 1990.

D. PLANNING

5. Research and Investigations

A. Distribution and ecology of Spartina foliosa and Spartina alterniflora in south San Francisco Bay.

John Callaway, Master's Degree Candidate, San Francisco State University.

This study, initiated in 1988, focuses on the distribution and interaction between S. foliosa a native cordgrass, and S. alterniflora an introduced cordgrass. Major objectives for the study are as follows:

1. Document the current distribution
2. Determine germination and growth rates
3. Response to experimental manipulation and removal

B. Shorebird census of northern and central California coastal wetlands

Lynne Stenzel, Janet Kjelmyr, Gary Page and David Shuford, Point Reyes Bird Observatory (PRBO)

In 1988, PRBO began this project to determine the status and future prospects for shorebirds in coastal wetlands in the Pacific Flyway. The first step of the project was taken in April, when 183 volunteer observers conducted the first comprehensive census of all shorebirds in San Francisco Bay. Refuge staff assisted by counting several areas on the Refuge. Over 838,000 shorebirds were counted; this identified the Bay as one of the most important spring concentration sites for shorebirds along the Pacific Flyway. A second census was conducted between September 8-12, during the fall migration. During the second census 345 observers counted shorebirds in all major coastal California wetlands between the Oregon-California border and Morro Bay. A total of 378,612 shorebirds was counted in the San Francisco Bay system. This project will continue for several more years.

C. Distribution and abundance of waterfowl in San Francisco Bay:

Refuge Biologists

We began a cooperative study with the Northern Prairie Field Research Station - Dixon in October 1987. Our role was to conduct monthly aerial waterfowl surveys of the entire Bay and refine methodology in preparation for more intensive surveying (twice every month) to be conducted in 1988-90. Louise Accurso coordinated the survey effort, and in fall 1988, she began work on this project for her Master's thesis as a coop student. Surveys were conducted beginning in September and a total of 14 survey days were flown through the end of the year. Loran coordinates were used to identify transects, and coordinates were continuously recorded by computer in the plane, which will make it possible to accurately map bird distribution. Little is known about seasonal change and distribution of waterfowl in the Bay estuary. This study will provide us with a foundation of knowledge, essential for improving management of waterfowl habitat. Some preliminary results are reported in section G.3.

D. California gull chick diet in south San Francisco Bay:

Jan Dierks - Masters Degree candidate at Moss Landing.

The summer of 1988 served as the second field season for this two-year study conducted on the Knapp Unit. Field methods included the collection of chick regurgitations and general observations of adult and chick interactions throughout the day. A status report indicates the majority of the food items in the chicks diet are obtained by the adults foraging at the local sanitary landfills. Refuge biologists assisted with the night-time collection of food items. Jan expects to complete her thesis in late 1989.

E. California least tern use of post-breeding foraging areas in the San Francisco.

Laura Collins - Field Biologist under contract with the California Department of Fish and Game.

The study originated in 1985 and will continue through 1989. Preliminary results indicate the least terns are using low salinity salt ponds in the far south bay during the late summer months. A final report will be developed in 1989.

F. Warm Springs Marsh Restoration:

John Williams and Philip Williams - Hydrologists, Philip Williams and Associates, San Francisco, CA.

This three-year project involved a detailed monitoring plan designed to measure channel erosion and deposition, deposition in the embayment, and changes in the local tidal hydrodynamics. The 250 acre study site is located on the Refuge in south San Francisco Bay. A preliminary report indicates sedimentation rates as high as 4-6 feet per year within the embayment. A large segment of the open water area will eventually fill in within the next 10-20 years. A final report is expected in 1989-1990.

San Francisco Bay contaminant monitoring study:

Refuge Biologists

The Refuge received $105,000 in FY 1988 to conduct a contaminant monitoring study on four of the refuges in the complex. (Studies for each refuge program are described here rather than under each refuge individually.) This was the third year of the program that was initiated in 1986 as a result of the Threats and Conflicts process conducted in the 1980's. Potential pollution problems identified included agricultural runoff at Salinas River, industrial, municipal, and agricultural runoff into San Francisco and San Pablo Bays, and landfill leachate at Humboldt Bay. The program objectives have been to identify contaminants and levels of concern to refuge fish and wildlife. During this year, Refuge staff collected over 250 biological samples. These included fish, bivalves and shrimp from Salinas River, and San Francisco and San Pablo bays, common murres from waters off of the Farallon Islands (collected by the Point Reyes Bird Observatory), and waterfowl eggs from San Francisco and San Pablo Bays. All samples except for fish and shrimp had been submitted for analysis by the end of the year.

Among the sites where bivalves were collected included areas affected by a major oil spill which occurred during the spring. Coincidentally, samples had been collected from these locations just prior to the spill. Samples continued to be collected periodically throughout the year in order to determine the exposure and long-term fate of the contaminants associated with this spill. Bivalves were also collected simultaneously from areas where canvasback were taken or contaminant analyses by Region 8 research scientists. This cooperative study was initiated to determine potential routes of contaminant uptake in wintering waterfowl, by examining the relationship between levels of contaminants in canvasback and bivalves which form an important part of their diet.

By the end of the year, reports on contaminants in California clapper rail and wintering waterfowl collected in 1986-87 from San Francisco Bay were in the early stages of preparation. Preliminary results indicated the presence of elevated, and potentially toxic, concentrations of mercury and selenium in both groups.

Refuge biologists collecting ribbed horse mussels in a cordgrass marsh as part of our contaminant monitoring study. (Photo - JT - 1988)

E. ADMINISTRATION

1. Personnel

PERSONNEL

1. Rick Coleman - Project Leader; GM-13, PFT
2. Ben Crabb - Assistant Project Leader; GS-12, PFT
3. Dick Munoz - Assistant Refuge Manager; GS-11, PFT
4. Charlotte Cox - Refuge Assistant; GS-5, PFT
5. Lois Sheldon - Refuge Assistant; GS-6, PFT
6. Joan Dawson - Clerk-typist; GS-4, PFT
7. Kathy Zeliff - Clerk-typist; GS-4, PFT
8. Olive V. Carter - Clerk-typist; GS-4, PFT
9. Jean Takekawa - Wildlife Biologist; GS-11, PFT
10. Kevin Foerster - Wildlife Biologist; GS-9, PFT
11. Louise Accurso - Bio. Tech./Coop. Ed. Student (Wild. Bio.); GS-7, PFT
12. David Lonzarich, Fisheries Biologist; GS-7, TFT
13. Donna Stanek - Outdoor Recreation Planner; GS-11, PFT
14. John Steiner -Park Ranger; GS-9, PFT
15. Marilynn Friley - Park Ranger; (Volunteer Coordinator); GS-7, PFT
16. Linda Drey - Park Ranger; (Interpretation); GS-7, PFT
17. Kim Dreyfuss - Park Ranger; GS-5, TFT
18. Sheila McCartan - Park Ranger; (Volunteer Coordinator); GS-7, PFT
19. Debby Johnston - Environmental Education Specialist; GS-9, PFT
20. Frances McTamaney - Environmental Education Specialist; GS-7, PFT
21. Ev Drakoulias, Park Ranger; GS-5, TFT
22. Jim Ferrier - Police Officer; GS-7, PFT
23. Jon Adamson - Police Officer; GS-7, PFT
24. Bob Bolenbaugh - Police Officer; GS-7, PFT
25. Barry Tarbet - Police Officer; GS-7, PFT
26. Steve Lewis - Maintenance Worker; WG-8, PFT
27. Mike Bitsko - Maintenance Worker; WG-8, PFT
28. Beth McCoy - Maintenance Worker; WG-5, TFT
29. Eric Nelson - Coop. Ed. Student (Wildlife Biologist); GS-7, PPT

The following personnel changes/actions occurred during 1988:

Name	Position/Grade	Action
Charlotte Cox	Refuge Assistant GS-0303-05	Resignation 06-17-88
Lois Sheldon	Refuge Assistant GS-6	Transfer IN 11/6/88
Kathy Zeliff	Clerk-Typist GS-4	EOD 3/28/88 Career Cond. PFT 11/20/88
Kevin Foerster	Wildlife Biologist GS-9	EOD 5-8-88 Career Cond. PFT
Louise Accurso	Coop Ed. Student (Wildlife Biologist) GS-7	EOD 9/25/88 (from Bio. Tech, GS-5)
David Lonzarich	Bio Tech. Fisheries Biologist GS-7	EOD 1/19/88 Promotion 8/14/88
Donna Stanek	Outdoor Recreation Planner GS-11	Transferred OUT 6/18/89
Olive V. Carter	Clerk-typist GS-4	Resignation 2/17/88
Marilynn Friley	Park Ranger GS-7	Reassignment 8/14/88
Linda Drey	Park Ranger GS-7	Resignation 2/13/88
Kim Dreyfuss	Park Ranger GS-5	Resignation 12/30/88
Sheila McCartan	Park Ranger GS-7	EOD 10/9/88
Debby Johnston	Environmental Education Spec. GS-9	Resignation 10/15/88
Ev Drakoulias	Park Ranger GS-5	EOD 7/17/88
Beth McCoy	Maintenance Worker WG-5	EOD 3/28/88

	Permanent		Temporary			
FY	Full Time	Part Time	Full Time	Part Time	CS	Intermittent
87	20		3	1(HBNWR)		
86	19		1	(HBNWR)		
85	19		1	(HBNWR)		
84	19			1(HBNWR)		
83	12	3		3	1	1

2. Youth Program

B. Eagle Scout Projects - BSA

During 1988, the Refuge had 9 employees involved with the Boy Scouts of America. A total of 727 hours, consisting of 102 hours of duty time and 625 hours of volunteer time, were logged.

Staff members were involved with the completion of two Eagle Scout Projects; provided supervision to 8 scouts who worked an excess of 50 hours earning public service time for rank advancement; set-up and supervised 200 plus hours of public service time leading to youth Congressional Awards and served as merit badge counselors (Rifle Shooting, Finger Printing, Nature, Bird Study, Safety, Soil and Water Conservation and Fish & Wildlife Management). A 7-hour class was conducted for Environment and Conservation Skill Awards. One staff member assisted two scouts as their Hornaday Award Advisor and served as an Assistant Scoutmaster.

During August and September meetings were held with the Mission Peak District (Southern, Alameda County) Explorer Executive regarding the establishment of a Conservation/Natural Resource Explorer Post to be sponsored by the Refuge. An open house held on October 25, 1988 resulted in 25 youth and 6 adults being registered. The Refuge received the official Charter during December by which time the 14 girls and 11 boys were actively involved in Post Activities.

Seven boys earned the Take Pride in America Patch and Service bar during the year. Several boys were working on the other Community Service Award Patch: Hometown U.S.A.

4. Volunteer Program

The San Francisco Bay NWR volunteer program continued to be successful during 1988, with both the Service and the individual volunteers benefiting during the course of the year. Volunteers donated approximately 10,600 hours of time to the Service. This is, however, a decrease in hours from 1987. This decrease in hours is attributed to the many staff vacancies in the public use area during the entire year of 1988. Most importantly, the Refuge did not have a staff person in the volunteer coordinator position for the first nine months of the year. Most of the hours volunteers contribute are in the public use area. Consistent staffing and program management are necessary for a volunteer programs stability and growth.

The Refuge hosted 8 interns through the Student Conservation Association program (SCA) in 1988 who contributed 3624 hours to Refuge programs. These hours are included in the total volunteer hours. There were three fewer SCA interns in 1988 than in 1987.

The non-SCA volunteers saved the government more than $43,500 in wages alone (based on the salary of a GS-7 employee). The number of active volunteers varied from 21 to 43 during the year. There were 75 active volunteers.

Though volunteers are requested to donate at least 16 hours per month, individuals actually donated from 4 to 80 hours per month.

Volunteers were involved in a variety of tasks and projects, ranging from interpretation, to biological research, to maintenance work. Approximately 77% of volunteer time was spent in the interpretive and environmental education divisions with the remaining 23% spent in the resource management and maintenance divisions. Volunteers were involved in the following:

Interpretation. Volunteers staffed the information desk and book sales area, and accounted for 98% of the fixed duty hours in the Visitor Center. Due to this valuable donation of time and effort by our volunteers, we are able to keep the Visitor Center open to the public 7 days a week. Volunteers patrolled refuge trails and spoke with hikers, birders, fishermen and joggers that they encountered. During these patrols they took visitor censuses for our public use reports, made note of any needed maintenance, picked up litter and watched for signs of vandalism.

Volunteers led and assisted in the presentation of numerous tours and talks throughout the year. Volunteers were largely (99%) responsible for a popular van tour of the abandoned ghost town of Drawbridge and tours of satellite refuges. We occasionally presented an evening astronomy program for Refuge visitors, thanks to the efforts of two of our stargazing volunteers. Without our Refuge volunteers, many special programs such as "Kids Day", "Open Houses", "National Wildlife Week" and "Annual Wildlife Art Show" would not have been possible. They also staffed booths at various information community and environmental fairs. Without their efforts many people would not know about the Refuge or the Service.

Resource Management. Volunteers lent a helping hand for surveys and censuses such as the Aleutian Canada Goose and clamming projects. In addition, a number of work parties occurred throughout the year at two of our satellite refuges. A number of volunteers helped with exotic species removal (plants) and revegetation at Antioch Dunes NWR. During the Coast Clean-Up Day, a large group of volunteers helped remove garbage from the Shoreline Trail.

Student Conservation Association Interns. During the course of 1988, eight full-time 12-week appointments were filled with volunteers through the Student Conservation Association. In exchange for their full time volunteer services, the Refuge provided them with housing and a small subsistence of $50.00 per week. The SCA interns are an invaluable asset to the Refuge program. They have provided us with professional and quality work. It is always enjoyable to work with them.

One advantage of the location of an urban wildlife refuge is that there is a large population base located nearby that serves as a vast reservoir of potential volunteer candidates. The Refuge is able to have a successful program, because normally there are adequate numbers of interested people on our waiting list to replace those volunteers who drop out of the program. We recruit new people through local public volunteers who drop out of the program. We recruit new people through local public service announcements, attending and hosting community service club meetings, displays at various off-site information fairs in which the Refuge participates, word of mouth advertising, and articles in the quarterly Tideline newsletter. An application/brochure describing the volunteer program is also available in the Visitor Center.

In April, Refuge volunteers were recognized for their efforts at the 6th annual Awards Banquet. The Refuge splurged and had another steak feed (with funding coming from the SFB Wildlife Society). A great time was had by all! All the volunteers received Certificates of Appreciation. Seven outstanding volunteers, who donated the most time throughout the year received special recognition. This was the third year the Refuge gave a "Volunteer of the Year Award". Lee Lovelady received the award this year.

5. Funding

All units in the Complex were funded this year as the San Francisco Bay National Wildlife Refuge Complex. The operating budget (O&M) for FY88 is:

	1260	FIRE	1971	7201
O&M (1261)	576.0			
RPRP Contaminants	115.0			
Challenge Grants	13.2			
Special	36.9			
Maintenance (1262)	129.2			
Sm. AARM	189.3			
Lg. AARM (R.O.)	118.0			
Total	1,296.4	1.1	6.0	3.75

The operating budget for the Complex in FY87 was:

	1260	1113	1262(YC)	1975	7201
O&M	592.6				
RPRP Contaminants	98.0				
Other RPRP	58.0				
Maintenance					
Sm. & Lg. AARM	346.2				
TOTAL	1,094.8	10.0	25.5	35.0	8.0

The operating budget for FY 84 - 86 are shown for comparison below:

FY	1210(MB)	1220(MNB)	1230(ADC)	1240(I&R)	1400(SE)
86	957.4				10.0
85	717.4				15.0
84	805.0				15.0

6. Safety

a. Safety Programs

Safety programs presented during the year included the following:

--Accident prevention
--Defensive driving
--Films on water safety
--Aircraft safety
--Handouts
Sexual Assault Preventive Handbook,
Home Hazard Hunt, Earthquake Preparedness,
plus other misc. material

b. Accidents

1988's safety record showed a 21% improvement over 1987.

We had four accidents involving falls by visitors, staff, and volunteers. None of the falls resulted in serious injury. One staff member's eye was scratched while operating the airboat. One SCA received a skin rash from poison oak. A maintenance man received a severe cut on his hand with a power saw while cutting plywood. He placed his supporting hand under the material and ahead of the saw. Following surgery and therapy he has apparently completely recovered. A memo was sent to all of the staff, SCA's, and volunteers as a reminder of what could happen through inattention or when distracted.

There was no YCC program this year. There were no reported bicycle accidents in 1988.

There were also four vehicle accidents involving staff, volunteers or SCA's. No injuries were reported in any of these accidents. Approximately 12 accidents occurred on State Route 84 which runs through the Refuge and parallel to Marshlands Road. Vehicles and or debris ended up on Marshlands Road or in salt ponds as a result of these accidents. All accidents were handled by the California Highway Patrol. The fence separating SR 84 and Marshlands Road was damaged in each of the accidents, sometimes blocking the bicycle path. Caltrans (CA Highway Department) was very prompt with repairs, usually clearing the hazard within 24 hours and repairing the fence within two weeks.

c. Safety Committee

The safety committee consists of a representative from the following units on the Refuge complex: Public Safety I&R Program, Environmental Education Center, Biologists, Administration and Maintenance (chairperson).

d. Safety Committee Actions

The committee reviewed all accidents that occurred on the complex and made recommendations and suggestions as needed.

e. Inspections - Non Refuge Personnel

Fremont Fire Department made quarterly inspections of the Headquarters-Visitor Center. The fire hydrant was checked for flow and all extinguishers were inspected and serviced as needed.

The San Jose Fire Department inspected the Environmental Education Center and the Alviso Central Site at least twice during 1988.

8. Other Items

Leslie Salt Company utilizes the ponds on the Knapp Tract, Alviso Unit, as a part of their production cycle. The annual fee to the Service for the use of this 452 acre tract is $3,500.00.

The three pay phones located on the Refuge continue to generate approximately $70.00 - $75.00 per year.

Revenue sharing payments totaling $51,614.00 were paid as follows: Alameda County $30970.00; Santa Clara County $16726.00; and San Mateo County $3918.00. This represents 71% of the total amount authorized.

F. HABITAT MANAGEMENT

2. Wetlands

Substantial progress was made on a project to restore a 150 acre area (Tract 102) of salt crystallizer ponds into wetlands. The Division of Engineering in the Portland Regional Office developed a design and permit package based on our proposal, which consisted of some dredge and dike building work, installation of water control structures, boardwalks, bridges and a windmill.

Permit applications were submitted to the Corps of Engineers (CORPS) and the Bay Conservation and Development Commission (BCDC) in March and June, respectively. Final approval was not received until November 1988. In the interim, we received a Notice of Violation from the Bay Area Air Quality Management District for excessive visible emissions (dust). The local air quality inspector happens to live downwind of the Tract 102 and was not happy about the dust blowing his way. The Notice of Violation carried a fine of $150 per day until the violation was corrected. We were unable to correct the problem immediately (by flooding the area) because we did not have the required permits from the Corps or BCDC. Fortunately, after much paperwork and negotiations, we received a short-term variance and paid a reduced fine of $112.00. Soon thereafter, we received authorization from the Corps & BCDC to begin construction; unfortunately, the winter rains had already set in. Nonetheless, we rented a bulldozer, fired up the Gradall, and proceeded cautiously.

The construction work in the area lasted until late December when the rain finally drove us out of the mud. By that time, we were able to re-direct a main channel, build a dike and breach the major levee. Tidal water could now flood a major portion of the site on a regular basis.

Management at this site, through retention of tidal waters and freshwater runoff, will provide foraging areas for wintering shorebirds and waterfowl during all tidal conditions. During the summer, the dried salt pond surfaces will provide nesting substrate for snowy plovers. An adult plover with two chicks was seen there in May 1987. Two wooden flap gates effectively held bay water in two ponds units during winter flood tides. These were regularly used by hundreds of avocets and black-necked stilts during the winter. Shorebird use peaked at over 20,000, predominantly western sandpipers. Biological staff and SCA volunteers conducted a wildlife and water monitoring program on Tract 102 to assess the effects of habitat management efforts. Construction activities will continue through the summer of 1990.

Maintenance worker Steve Lewis using the Gradall to breach a levee in Tract 102. (Photo - KSF - 12/88)

A ripped and non-ripped section of a former salt crystallizer pond in Tract 102. We ripped four separate sections using a rented D-3 bulldozer. Refuge biologists will determine the response of the invertebrate fauna shorebirds to the treatments. (Photo - KSF - 12/88)

A draft plan was developed for the proposed enhancement of New Chicago Marsh, adjacent to our Environmental Education Center in Alviso. This area, which historically supported tidal marshland, became isolated from the bay by the construction of the salt evaporation ponds during the 1920's. Introduction of bay water would improve water circulation and enhance the site for both wintering and breeding waterbirds. Funding for this enhancement will originate from fines that were levied against the City of San Jose for a series of sewage upsets at their Santa Clara Pollution Control Plant in 1979 and 1980. Peninsula Open Space Trust is responsible for disbursement of these funds, which may also go toward construction of a colonial bird observation tower near the EEC.

Refuge staff continued to manage five abandoned salt evaporation ponds south of Highway 84 and west of the headquarters/visitor center. By leaving a tide gate continually open, tidal access was restored to the first four ponds in the series. A wooden flap gate was installed at the entrance of the fifth pond allowing tidal waters to be held back and maintained at depths suitable for waterfowl, such as shoveler, ruddy duck and scaup. It was then drained in the spring to provide nesting habitat for snowy plovers. A peak of 12 plovers and at least two nests were observed in 1988.

In 1986 the Refuge acquired a 250 acre parcel of historic bay marshland, which was restored to tidal action as mitigation for construction of an approximately 400 acre industrial park in Fremont. Restoration of the area increased the volume of tidal water moving through the sloughs and creeks which enter the southern arm of San Francisco Bay. This will in turn facilitate scouring and erosion of these channels, many which have become clogged by depositing silts and clays. The majority of the property consists of a large tidal pond, which by late fall supported several hundred ducks including scaup, canvasback, pintail, mallard, wigeon and cinnamon teal, and an occasional harbor seal. It was also a roost site for over 3,000 California gulls. In addition, the parcel included a 27 acre diked pickleweed marsh, to be managed for the endangered salt marsh harvest mouse. Two screwgates make it possible to introduce tidal water. However, when the 27-acre parcel was flooded in the spring of 1987, a major mosquito outbreak resulted. It then became necessary to drain the property and the local mosquito abatement district sprayed it with a biological control agent. Two meetings were held in 1988 with the mosquito abatement specialists to incorporate their concerns into the management plan for the area. In addition, we requested the assistance of the Division of Engineering - Portland Regional Office to develop a topographic map of the site. An engineer will visit the site in early 1989, and an appropriate restoration and management plan will be developed.

The Refuge assumed responsibility for a tide gate on Mud Slough in 1988. Note the elevational differences between the foreground and background. (Photo - KSF - 9/88)

6. Other Habitats

The Refuge contains approximately 9000 acres of solar salt evaporation ponds operated by the Leslie Salt Company. Unfortunately, when the Service gained ownership of the ponds, we did not obtain management rights to the area. Since Leslie may continue to harvest salt in the ponds in perpetuity, the refuge has little input in management of the ponds. In the eventuality that Leslie may someday cease salt making operations, all management rights revert to the Service. Therefore, we have been conducting monitoring studies of the salt ponds to understand the biological processes of this unique habitat.

In tidal intake ponds and early series salt ponds, the water remains fairly clear, with salinities ranging from that of the bay waters to double the normal salinity. In these ponds wigeon grass grows profusely, attracting large numbers of waterfowl, including shoveler, pintail, gadwall and canvasback. Fish can also survive in these ponds and some species reproduce there. The common species are long-jawed mudsucker, three-spined stickleback, staghorn sculpin, topsmelt and others. These fish attract thousands of fish-eating birds, such as white and brown pelicans, double-crested cormorants, terns, herons and egrets.

As salinities increase in the solar salt pond series, algae and halophytic bacterial blooms occur, turning the water into various shades of brown, green, orange, pink and red. The algae are fed upon by brine shrimp (Artemia sp.) which then undergo mass population blooms. Brine shrimp and brine shrimp eggs were harvested commercially on Refuge salt ponds via a contract inherited by the Service from the previous owner. During 1984, this contract expired and a temporary extension was given. In 1987, a contract was awarded to a new contractor, the Novalek Company. For the first time, the harvest of brine shrimp eggs (actually more lucrative than the sale of shrimp) was included in the contract, to insure that the federal government would receive revenues for this additional harvest. Also for the first time, two ponds were withheld from harvest to make it possible to investigate the potential impacts that harvesting has on brine shrimp populations. The new company is more research oriented, and plans to do studies to learn more about brine shrimp biology and population dynamics. Meanwhile, the former contractor, Bay Brands, has sued the Fish and Wildlife Service. They continue to harvest shrimp in adjacent salt ponds in the South Bay under contract with the Leslie Salt Company. The new harvesting agreement should provide increased revenue and greater control over the harvest to the benefit of wildlife.

Brine shrimp and invertebrates such as brine flies and water boatmen are extremely important to many migratory birds using the salt ponds. Scaup, ruddy duck and bufflehead utilize this food source heavily along with thousands of eared grebes, phalaropes, California gulls, black-necked stilts, American avocets and other sandpipers and plovers. Our long range goals are to gain complete management control of the salt ponds and boost production of fish and invertebrates in the appropriate salt ponds for the benefit of migratory bird populations as well as commercial harvest if compatible. Those salt ponds of low biological value will be restored to tidal marsh.

G. WILDLIFE

2. Endangered and/or Threatened Species

a. California Brown Pelican

As in previous years, brown pelican use of south San Francisco Bay continued at a relatively low level compared to other areas on the central California Coast. Major use areas for this species include central San Francisco Bay, the Farallon Islands and Monterey Bay. Approximately 150-200 pelicans normally inhabit the salt ponds and open bay, both on Refuge lands and on adjacent property. High use areas were low salinity (30-45 ppt) salt ponds where birds frequently display a rather atypical surface feeding behavior. Pond levees also provided roosting sites for this species.

b. American Peregrine Falcon

This species may be encountered year-round in south San Francisco Bay, however, most records occur during late fall and winter. The abundant shorebird and waterfowl populations utilizing San Francisco Bay during the winter and migrational periods provide a readily available prey base for this avian predator. Peregrines were occasionally sighted in the vicinity of the headquarters and Dumbarton Bridge. In early fall, peregrine falcons were observed foraging at the Dumbarton Railroad Bridge, Knapp Property and the Palo Alto Baylands.

c. California Least Tern

Management efforts for this species consist of improving the habitat and monitoring breeding effort at the primary South Bay colony. This colony, which was historically located on the dried surface of an abandoned salt pond near Redwood City, has not supported successful nesting for the past three years. Reasons for abandonment are not clear, but may be due primarily to encroachment by vegetation (Salicornia) into the site and/or because Caspian Terns, which provide protection from raptor predation, also abandoned the site two years ago. Monitoring was conducted by volunteers with the San Francisco Bay Bird Observatory. The California Department of Fish and Game (CDFG), which owns the property, has expended considerable efforts in protecting the site from tidal inundation and is attempting to make it more attractive to terns. During 1987, they finished rehabilitation of levees surrounding the site, moved oyster shell onto the levees to provide suitable nesting substrate and built a nesting platform of shell. Caspian terns recolonized the site in 1987. The population peaked at 1700 birds in 1988, however least terns have not returned to nest.

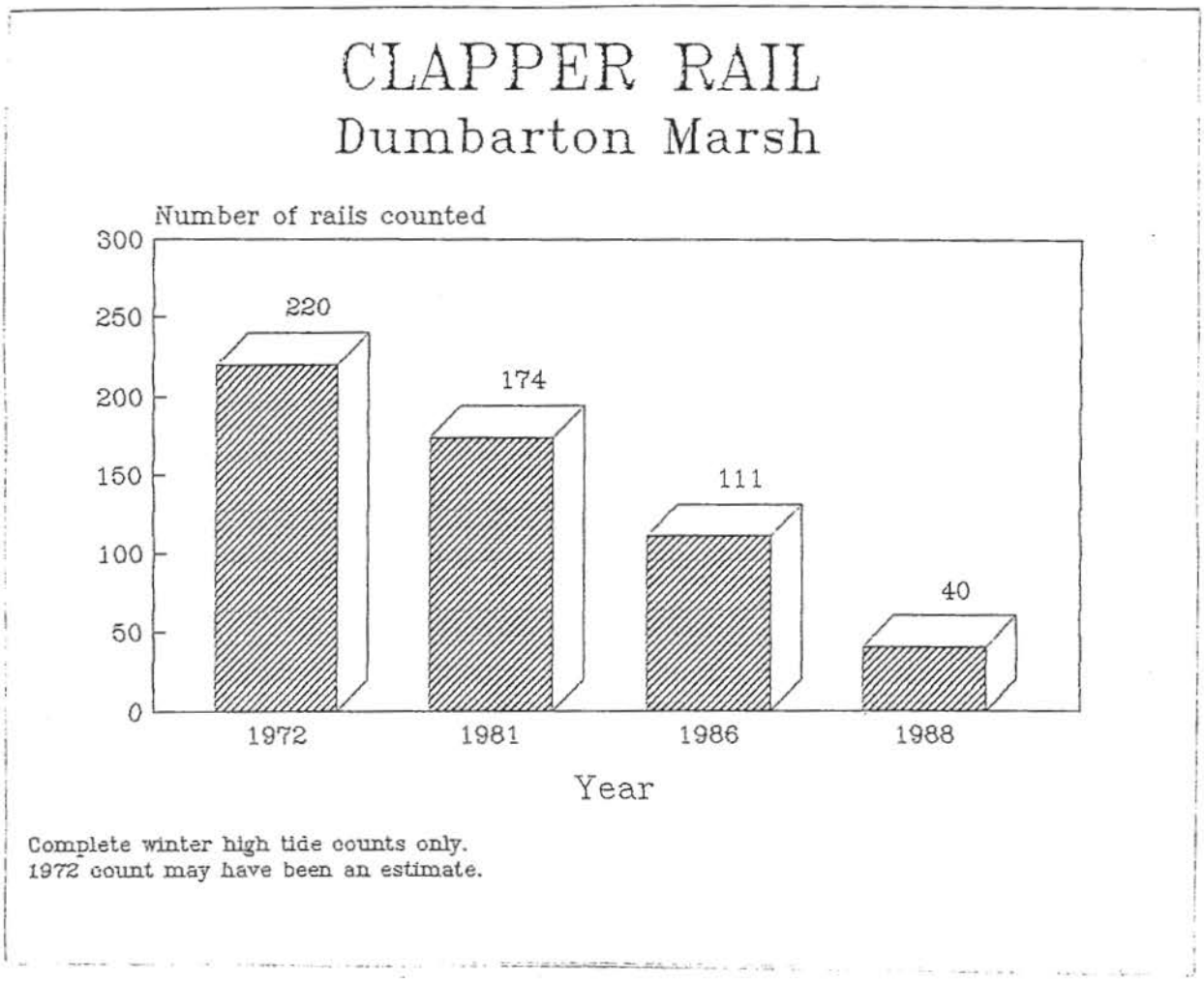
A survey by researchers (D.5) showed that least terns forage in the lower salinity salt ponds in the south bay during the late summer months.

d. California Clapper Rail

Non-breeding season surveys for clapper rails were conducted during extreme high tides (9.0 feet above mean lower low water) when the vegetative cover is minimal and the rails are easily counted. A survey of Dumbarton Marsh produced a total of 40 rails, a significant decrease from surveys conducted in the 1970's and early 1980's. A cooperative survey by Refuge and CDFG biologists indicated that fewer rails now inhabit the southernmost end of the bay, probably because the tidal marshes have been influenced by fresh water effluents and no longer support the pickleweed/cordgrass community typically inhabited by rails.

A rough updated population estimate was developed in 1988 based on airboat surveys conducted since the early 1980's. Total numbers may range between 500-1000 individuals: much lower than the previous estimates of 4,000-6,000 birds. The majority of the population has historically been concentrated in the south bay. The habitat loss due to the fresh water effluent has created a tremendous stress on the population. More surveys will be conducted in 1989 during the breeding and non-breeding seasons to update the population estimate in specific marshes.

Refuge and Fish & Game Biologists discussing airboat transects prior to a high tide. (Photo - JT - 12/88)



Surveys indicated a significant decline in the number of clapper rails in Dumbarton Marsh since 1972. All surveys were conducted on airboats except the 1972 survey, which was conducted by observers on the levee.

Predation was a growing concern as sightings of non-native red foxes increased tremendously in the south bay (G.15). Rat populations in refuge marshes appear to have decreased since the early 1980's.

Resightings of individually-color banded California clapper rails also continued as part of a joint refuge/San Francisco Bay Bird Observatory project. Resightings or recaptures of banded individuals have revealed a high degree of territorial site fidelity within the south San Francisco Bay rail population. For example, of 50 individuals that have been resighted at least once, 32 (64%) were observed 100 meters or less and 13 (26%) were observed 100-500 meters from their original capture sites. Four individuals have been recorded moving distances of 1 kilometer or more between different salt marsh parcels. One of these was resighted 10.5 kilometers from it's initial capture location. In 1986, 24 California clapper rail eggs were collected for selenium, mercury, and organochlorine residue analyses. They were collected from tidal marshes on and off the Refuge, in both the North and South Bay. Preliminary results from the 1986 samples indicated that organochlorine levels were relatively low. However, selenium levels were higher in certain North Bay sites adjacent to refineries than in South Bay sites. To increase the small sample size in these sites (from two), six more eggs were collected there in 1987. In addition, eight clapper

rail eggs were collected for us in North Carolina to provide a comparison with a relatively clean site. After a long wait, we received the laboratory analyses. A preliminary analysis of the results suggests that mercury and selenium concentrations were higher in the rail eggs in San Francisco Bay than in the North Carolina eggs. A report summarizing the results will be prepared in 1989.

e. Salt Marsh Harvest Mouse

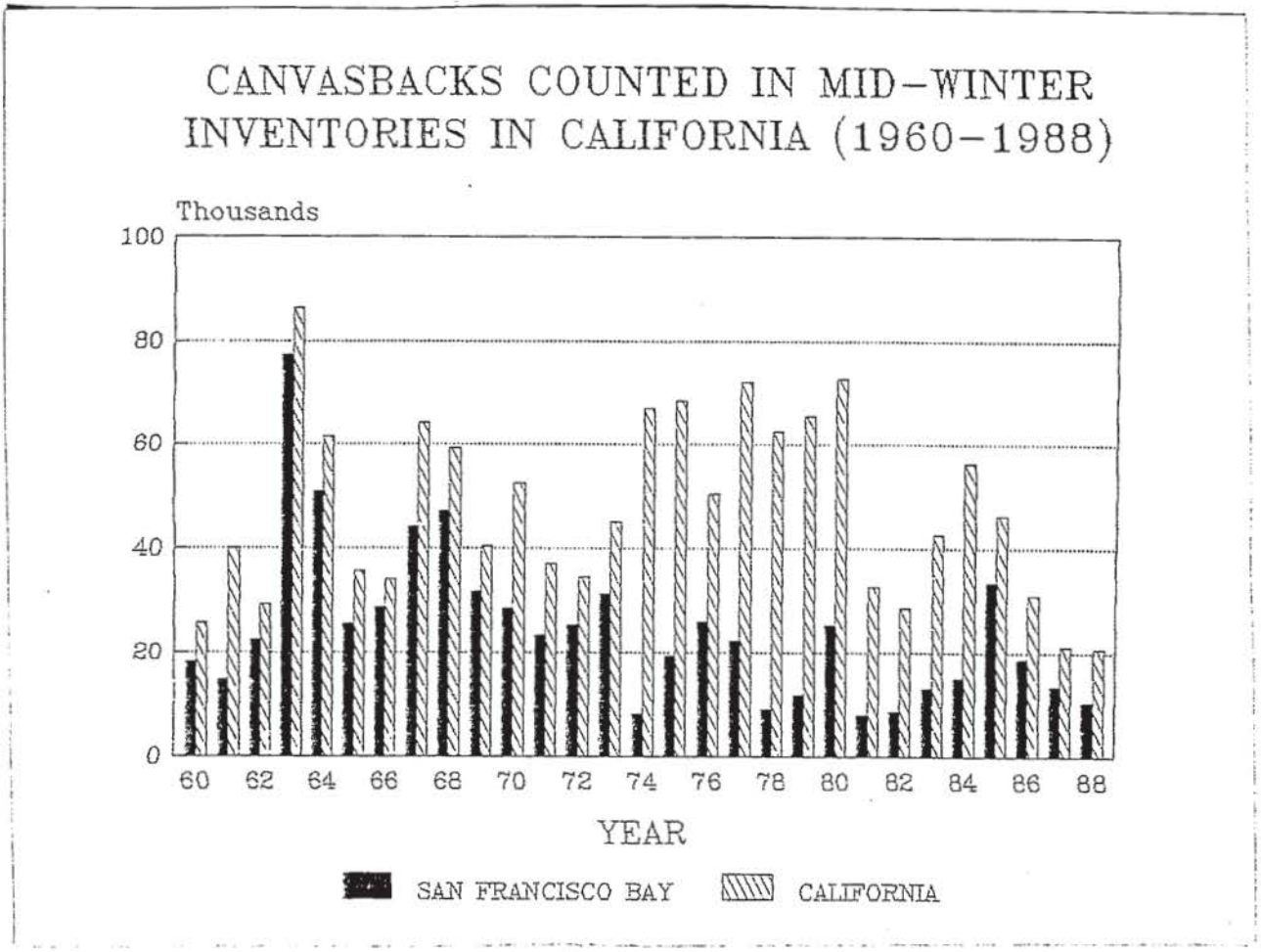
New Chicago Marsh continued to support a significant mouse population in its western end. Refuge staff assisted Dr. Howard Shellhammer with trapping efforts in this area. Refuge staff applied for, and received, state and federal permits to conduct salt marsh harvest mouse trapping on the Refuge. Trapping will begin in early 1989 on the Warm Springs "mouse pasture."

f. Aleutian Canada Goose

We continued to monitor the Aleutian Canada Goose population that overwinters around the East Bay reservoir system, mostly through a volunteer effort. Numbers peaked at 56 in 1988-89 around the Nunes ranch stock pond compared to a high of 140 in 1984-85. Although the Aleutian Canada Goose population in the Pacific Flyway has increased in recent years, the wintering population at the Nunes Ranch has decreased substantially since the 1984-85 season. The decrease may be attributed to increasing human development and several years of dry conditions that resulted in poor quality forage grasses. In 1988-89, the geese arrived in early December, foraged for two weeks, left for 33 days, then returned to forage in the area until late January 1989.

3. Waterfowl

More intensive monthly waterfowl surveys were conducted in 1987-88 (December through March) and expanded in the fall of 1988 (October through March). Aerial surveys were conducted over all of the open water of San Francisco Bay, as well as the salt ponds and other wetlands that fringe the Bay. By late 1988, each survey took 12 hours of flight time over two days to complete. During the 1987-88 season, waterfowl numbers peaked at over 200,000 in December. Species in greatest abundance included scaup, scoter, pintail, shoveler, ruddy, canvasback and wigeon, in decreasing order of abundance. Surveys confirmed that most puddle ducks occurred in the salt ponds, but that large numbers of canvasback and ruddy duck also used the ponds. Scaup and scoter numbers increased late in the season (February and March) in the central part of the open bay, which may indicate that some are using the bay as a staging area.



San Francisco Bay continues to be an important wintering area for canvasbacks.

During the 1986-87 season, CDFG biologists collected scaup and canvasback from four regions of the Bay for selenium analyses. Their results indicated that selenium residues were higher in scaup than in canvasback. Both selenium and mercury levels were higher in San Francisco Bay than in reference sites near Humboldt Bay.

4. Marsh and Water Birds

The Refuge currently supports one active breeding colony of herons and egrets along Mallard Slough. A second colony on Bair Island is located on private land immediately adjacent to the Refuge. The Bair Island colony was established in 1967 when great blue herons first colonized the area. Two years later, black-crowned night herons and snowy egrets initiated breeding activities on the island and the number of breeding pairs began to increase rapidly. The Mallard Slough colony was formed in 1976 when black-crowned night herons and snowy egrets began nesting at this site near the Environmental Education Center. At this site, nests are found in dense stands of hardstem bulrush which has become established in response to tremendous outflows of treated sewage effluent (120-150 million gallons per day) from the San Jose/Santa Clara Water Pollution Control Plant. In 1988, approximately 296 snowy egrets, 68 great egrets, 195 black-crowned night herons, 11 cattle egrets and 2 little blue herons were observed at the colony.

The Bair Island colony is situated on a dredge spoil site that supports a stand of coyote bush, thistles and annual grasses. Due to a combination of old age, lack of recruitment of new plants, and extensive use by nesting herons, the coyote bush stands are deteriorating. As a result, the herons & egrets have begun nesting on the ground and in the thistles where they are more susceptible to disturbance and predation. Several wooden nesting platforms were constructed and erected in 1986, however, the platforms have only been used for roosting. In 1988, the heronry consisted of 282 snowy egret nests, 197 black-crowned night heron nests, 18 great egret nests and 15 great blue heron nests.

5. Shorebirds, Gulls, Terns and Allied Species

Forster's and Caspian Terns have nested in south San Francisco Bay since 1948 and 1916, respectively. Prior to the conversion of the majority of tidal marshes around the bay into salt evaporation ponds, suitable habitat for nesting was not available for these and several other species including American avocet, black-necked stilt, snowy plover and California gull. However, the isolated dikes and islands in the ponds provide the predator-free habitat these species require.

Numbers of nesting terns in the south bay have declined in recent years with less than 3,100 Forster's and 2,100 Caspian terns breeding in 1988. This contrasts with previous totals of 5,000 Forster's and 2,400 Caspian terns censused in 1981. The significant declines observed in these tern populations are difficult to account for but may be related to a decrease in nesting habitat caused by dike maintenance and construction, marsh restoration or possibly relocation of birds to the Napa Marsh area.

Since 1981, California gulls have nested on islands in a salt pond acquired from The Nature Conservancy. In 1984 a second colony was discovered near the Leslie Salt Company plant in Newark and in 1985, a third colony appeared on the Knapp property on the Refuge at the south end of the Bay: The rapid establishment of this species in the south bay is particularly interesting since it demonstrates a westward range extension and departure from their more typical Great Basin nesting habitat. Numbers continued to increase dramatically from the 30 pairs encountered in 1981. This year, over 2000 nests were surveyed on the Knapp property. The Leslie Salt Company Plant Site supported 45 nests and the Pond A9 levee supported 15 nests in 1988. Because abundant invertebrates in the salt ponds and numerous landfill sites around the south bay provide an unlimited food source for gulls, the availability of secure nest sites may ultimately limit this breeding population. Monitoring of the gull breeding population was continued jointly with the San Francisco Bay Bird Observatory.

6. Raptors

On October 20, 1989, a field worker for the Leslie Salt Company reported sighting an injured red-tailed hawk on a refuge levee. Police officer Ferrier responded and observed three hawks on the ground near Drawbridge. Refuge manager Coleman and biologist Foerster arrived at the scene and assisted with the capture of the animals. All three birds were located on the ground below a small powerline that had been recently modified. The birds were covered with mud and appeared to be sick. There were no external signs of electrocution. The birds were taken to

a raptor rehabilitation specialist. The veterinarian diagnosed the hawks as suffering from trichomoniasis. The birds were treated and released in early 1989.

Refuge Manager, Rick Coleman and Police Officer, Jim Ferrier hold two of three red-tailed hawks that were captured on the Refuge.
(Photo - KSF - 10/88)

9. Marine Mammals

No reliable population estimates were made of the south bay harbor seal population this year, however, numbers at Mowry Slough have generally remained stable since the turn of the century. Seal use on the east side of Greco Island has increased in recent years and this site represents another important pupping site. Numbers of seals also haul out along Guadalupe Slough, Corkscrew Slough and Newark Slough. A study on the distribution and abundance of harbor seals in San Francisco Bay will be conducted in 1989 by independent researchers in cooperation with Refuge biologists.

15. Animal Control

Feral animals continued to be a problem on the Refuge. Feral cats, in particular, are frequently observed and trapped in the vicinity of the headquarters. They are turned over to the Tri-City Animal Control Shelter in Fremont. Of even greater concern was the increase in sightings of red fox in and around the Refuge. This non-native species has recently expanded its range

in California. The animals are thought to have been intentionally released by fox hunters and escapees from fox farms. Active dens were suspected at sites adjacent to the Refuge at Coyote Hills Regional Park and the Baumberg Tract. These effective predators have caused tremendous losses of least terns and clapper rails in southern California. They are very adept at hunting in salt marshes. Red fox control has been an extremely controversial issue in California. The Fish and Wildlife Service has been sued by an animal rights group in southern California in an attempt to stop control efforts. Accordingly, we are documenting all sightings and continue to work with the California Department of Fish and Game toward the development of a coordinated control effort.

16. Marking and Banding

This year marked the sixth year of color-banding young chicks from the major south bay California gull colony. Over 500 gull chicks were banded with USFWS bands by volunteers with the San Francisco Bay Bird Observatory.

17. Disease Prevention and Control

Botulism outbreaks have been recorded in the south bay in the past. The outbreaks have been aggravated by the discharge of sewage effluent (over 120 million gallons per day) into Mallard Slough and Coyote Creek. The area is monitored by members of the San Francisco Bay Bird Observatory under contract with the local dischargers. Fortunately, in 1988, only a few dead birds were collected and botulism was not a problem.

A small outbreak of trichomoniasis was reported in three red-tailed hawks captured on the Refuge (G.6).

H. PUBLIC USE

1. General

San Francisco Bay National Wildlife Refuge serves a dense, local population of more than 6 million people. It provides a perfect opportunity for Bay area urbanites to visit a relatively unspoiled area, enjoy the local wildlife and learn about nature, conservation and wildlife management. During 1988, over 300,000 people visited the Refuge; more than any previous year. Of these, 11,069 students and 2,028 teachers attended classroom activities at the Environmental Education Center in Alviso and the Visitor Center in Fremont. Forty thousand stopped in at the Visitor Center and 11,000 attended interpretive programs. Many more visitors received our self guided interpretive messages when they read our wayside exhibits.

Refuge personnel and volunteers conducted summer day camps at both centers. A total of 94 children participated.

Two thirds of our 1988 visitors participated in recreational activities other than formal programs at one of the centers. The public fishing area, trails and sloughs were used by visitors. Many of these people were contacted in the field by Refuge volunteers on patrol.

General public use is limited at the Environmental Education Center (EEC). The EEC is only open Monday through Friday between 8:00 am and 4:30 pm due to staffing constraints. The number of drop-in visitors that were counted totaled 5,091, an increase of 49% over 1986. A total of 32 special use groups utilized the EEC. Since the EEC is closed on weekends, a Public Open House was offered. Approximately 400 people attended and joined in the activities offered throughout the day.

2. Outdoor Classrooms - Students

The Environmental Education Center (EEC) was used extensively again this year. Primary use was school field trips, however other groups (such as scouts) also used the facility. During 1988, the Center devoted the first three weeks of September to curriculum development as demand for school group use during this time is limited. Fall reservations are taken starting August 1, and spring reservations are taken starting December 1. By the middle of February, 1988, all available dates for 1988 spring field trips had been booked. We have had very good luck with this new arrangement minimizing field trip cancellations which were hard to fill in previous years. The Center was visited by 8,389 students, and 1,467 teachers and parent leaders on all day field trips. The total visitor and field trip usage for 1988 was 12,772.

For six months of 1988 the Center operated short handed by one staff person. Again, this year as last year, there was more demand for our program than we were able to meet. To help alleviate this problem, we double-booked field trips in the spring. The second school that booked a field trip for the same day had access to equipment, use of the Center's habitats and a patio with picnic tables to use as their brine shrimp laboratory. The Center is unique in that the facility is designed to incorporate both laboratory and outside settings for use during field trips. Teaching aids and laboratory equipment, designed to enhance a student's basic observation skills, are provided for use during the field trips. Audio visual material, including films and slide shows, are provided. Field trips involve students in indoor and outdoor activities revolving around a central theme. A ratio of 10 students to 1 adult leader is strongly encouraged to provide an enhanced learning experience of the students while at the Refuge.

With only two full-time staff members, many of the demands for our programs would go unmet without the aid of student Conservation Aids (SCA) and a few dedicated volunteers. The volunteers and SCA's learn the basics of the EEC program and then either lead particular activities, present opening and closing programs and/or provide support to teachers/parent leaders during their activities. When not busy with visiting school groups, SCA and volunteers help the staff with special projects which enhance the educational experience for visitors.

The Refuge Visitor Center in Fremont phased out their two hour naturalist-led field trips by August of 1988 with a total of 3900 students, teachers and parents. Teacher-led field trips were offered the entire year serving 3741 students and 644 teacher/leaders on all day field trips. These teacher-led field trips are designed after the EEC model with the exception that more of the activities are conducted outdoors. An old pump house building that was converted to a lab classroom is being used as the gathering and equipment distribution

point. Eleven Teacher Orientation Workshops were held to train 153 teacher/ leaders and 29 teachers made use of the one hour planning sessions. Thirty visits were made by California State University, Hayward, field biology and ecology classes to conduct studies on the salt marsh.

The Visitor Center staff offers a summer day camp called "Junior Naturalists". This year a camp session ran for one week for four hours each day. The first session was attended by 20 3rd and 4th graders and the 2nd session by 20 5th and 6th graders. The naturalist staff designed and conducted these camps.

PHOTOGRAPH NOT AVAILABLE

Brine shrimp collection with students and teacher at the Visitor Center's salt pond.

The "Marsh-In" day camp was offered for the 7th consecutive year. Two sessions were attended by 38 4th, 5th and 6th graders. One overnighter at the EEC is included in each session; the program is primarily designed to reach children from the nearby community of Alviso. By involving these children in the EEC and the Refuge, we have been successful in gaining acceptance by the local community. Through the day camp, local children gain an understanding and respect for wildlife and the Refuge itself.

The second year of the five day program with an overnight was a huge success. The camp sessions are taught by seven local professional volunteer naturalists, many of whom have helped since "Marsh-In" began. The EEC staff conducts training sessions for the volunteers to introduce new activities used during the camp.

Aquatic Project WILD participants role playing birds in the activity "Migration Headache." The workshop was held at the EEC.

3. Outdoor Class Rooms - Teachers

The EEC offers teachers a unique environmental education opportunity. We provide a facility where teachers can lead their own field trips, following the training and guidance we provide. Teachers are highly involved in planning the trip, preparing students and conducting the field trips following the individual format designed by the teacher. This format provides both the teachers and students a learning environment which often extends into the classroom beyond the day spent on the Refuge. The EE staff, SCAs and volunteers offer training and support, both before and during the field trip. By encouraging teachers to prepare their field trips their and recruit parents to help conduct them, the EE staff can effectively reach more students with individual attention than if the staff conducted the field trips by themselves. A high adult to student ratio is important to enhance and increase the learning experience.

In the San Francisco Bay area, where many environmental education facilities and programs are available for teachers to choose from, the Refuge EE program is unique. By making teachers fully responsible and highly involved in their field trip, they are more likely to integrate the classroom curriculum with their field trip. As a result, students achieve a more meaningful, in-depth experience. A total of 12 3 1/2-hour teacher orientation workshops were

offered, with 179 individuals participating plus 62 teachers, who returned for one hour planning sessions. We offered 11 teacher orientations at the Fremont site for 153 participants and 29 teachers used the one hour planning session. Before a field trip to the Refuge can be scheduled, at least one adult must attend the workshop. The staff also is available for individual planning sessions should teachers require assistance in planning their trips. One night a month is reserved for teacher planning sessions. A special Teacher Open House was offered at EEC with 60 attending the all day program. The confidence obtained by the teacher and adult helpers at these orientation workshops is invaluable.

The EEC staff was actively involved throughout 1988 with Project WILD, which also offers its curriculum guide only through workshops. Project WILD is an interdisciplinary wildlife education program, which uses wildlife related instructional activities for grades K-12, whose overall purpose is to conserve wildlife and natural resources. Seven Project WILD workshops were offered with 181 participants. Two of these workshops were conducted with the new Aquatic Project WILD guide. This guide focuses on aquatic-related habitats and is a resource for teachers to use when teaching about the San Francisco Bay ecosystem. Three of the Project WILD workshops were conducted as an inservice for the Fremont Unified School district.

4. Interpretive Foot Trails

The Refuge has two trails with descriptive panels. These interpretive displays describe the habitat, cultural history, ecological dynamics and geology of the areas that visitors walk through. They are easy to read, visible without being intrusive and serve as a valuable supplement to our interpretive effort.

The self-guided trails are especially important during hours when the Visitor Center is closed. From 5pm to sunset, and before 10am, trail use is often heavy. Other periods of heavy self-guided trail use are legal holidays when the Visitor Center is closed. The Tidelands Trail is registered as a National Recreation Trail in the National Trails System.

6. Interpretive Exhibits and Demonstrations

During 1988, 142,000 visitors participated in interpretive activities at the Refuge. 131,000 took advantage of our self-guided interpretive trail or visited the interpretive center to watch films and look at the educational displays. The remaining 11,000 participated in the numerous naturalist-conducted programs such as walks, van tours, talks, slide presentations, and bicycle and canoe trips. The natural history of the Refuge was well represented in our 1988 programs with topics such as salt marsh ecology, insects, birds, seasonal wetlands, endangered species, edible plants, geology and mammals.

Our program audiences were as diverse as the program topics that we presented. Audubon chapters, day care centers, garden clubs, hospitals, scout troops, community groups, senior centers, teachers' associations and women's organizations, among many others, took advantage of the available programs. The greatest demand for naturalist-led activities, however, came from local schools as students from grades K through college, including special education groups,

discovered the wildlife resources of the Refuge and the Bay area. In 1988, 3,900 students and teachers participated in the educational programs presented by the naturalist staff and 3741 students and teachers participated in the teacher-led program.

Also popular were the tours of Drawbridge, an abandoned sportsmen's community in a salt marsh setting. The dilapidated town stands as a reminder of the consequences of human destruction of the native environment. This was the theme as 350 people visited the area during tours offered on Saturdays from May through October.

We also conducted nature walks, talks, slide shows and other interpretive programs for the public on Saturdays and Sundays throughout the year.

Our volunteers were quite active in giving public tours on the weekends during 1988. They covered such topics as geology, salt marsh ecology, birds and astronomy.

Numerous guest speakers provided insight into a variety of topics such as tropical rainforests, San Francisco Bay sharks, Indian basketry, conservation of natural resources, seasonal wetlands, Gulf of the Farallons National Marine Sanctuary, Cordell Banks and many more.

Many special events were also held at the Refuge during 1988, all with good success. In March, a Saturday and Sunday celebration of "National Wildlife Week" attracted 600 people. Staff and guest naturalists presented programs on birds of prey, snakes, local wildflowers, seals and other nature topics.

Our Kids' Fishing Derby in April attracted hundreds of youthful anglers who visited Dumbarton Pier with their parents to try their luck with hook and line. The local K-Mart donated fishing poles, reels, tackle boxes and other choice fishing gear as prizes for each age group. Winners in each of nine age categories (5 through 12 years of age, and over 12) were awarded a prize.

The fishing derby was organized and conducted by the "East Bay Sportsmen", a local fishing club with years of experience in fishing contests. Club members conducted registration, measurement of fish, assignment of prizes and helpful hints during the day.

On October 1, the Refuge held a plant sale. Three hundred and fifty horticultural enthusiasts visited the Refuge to buy native plants for their gardens, or to learn about them at the Native Plant Symposium which accompanied the all-day sale. The California Conservation Corps supplied the plants, which we sold at cost.

An "Open House", with something for everybody, was held on Halloween, October 31, at the Refuge Visitor Center. 400 people enjoyed film and slide presentations, Drawbridge tours and live music. Special activities, including apple bobbing, face painting and pumpkin decorating, were available for the younger set.

Our annual "Kids' Day" on November 21 was also well received with over 550 kids and parents in attendance. Programs included a live raptor program, bird-banding demonstration, storytelling, films and a program on whales complete with kids constructing a backbone from whale vertebrae.

We held several astronomy programs during the year. Volunteers Bill Delinges and Charles Crouch provided telescopes and expertise for the popular events. During the summer, 37 3rd, 4th, 5th, and 6th sixth graders participated in the Refuge's 8-week "Junior Naturalist" program. These young nature lovers met at the Visitor Center on Tuesday and Thursday of each week and learned about food webs, adaptations, predation and other ecological concepts as they discovered the worlds of mammals, birds, insects, reptiles, bayshore invertebrates and endangered species. Their response to the program was enthusiastic and positive. We have seen this program have a lasting effect on the participants, as they come back repeatedly to the Refuge to "check-in" and learn more.

Several off-site events helped to increase public recognition of the Refuge and its programs. Volunteers staffed information booths at local festivals such as Berkeley Bay Day, the Bay Area Environmental Education Resources Faire, Sulphur Creek Wildlife Day, People Pride and Progress in Newark, the Crab Cove Sea Fair and Wetlands Fair. Throughout the year, staff members spoke to numerous civic, business, church and social groups, providing nearby communities a service while disseminating information about the Refuge and its resources. Career talks were frequently given to students at local high schools and intermediate schools.

Throughout the year, the focus for the interpretive effort was the Visitor Center and the Environmental Education Center which was open during the summer on Sundays. Most of our programs were conducted at these 2 sites and tens of thousands of visitors dropped in at the visitor center reception desk.

Every day something is going on in our Visitor Center. Many of the programs and demonstrations are conceived, written, rehearsed and presented by volunteers.

Every day brings a steady stream of inquisitive Refuge visitors past our Visitor Center reception desk. Our volunteers who daily staff the desk are knowledgeable and always willing to help out. We would not be able to present the variety of programs we do without them.

The Visitor Center was kept open on all federal holidays except New Year's Day, Thanksgiving and Christmas.

In July, we closed down the auditorium and adjacent exhibit/lecture room for a major remodeling project (See Section I.1). When we reopened in September, we had a new walk-through exhibit area with dioramas and interactive exhibits, and a brand new auditorium complete with giant projection screen, storage closets, a diorama and a projector booth. This is a real improvement over the old days when we kept our projection equipment on a moveable cart and used a fold up screen!

7. Other Interpretive Programs

The Refuge participated in some non-traditional forms of interpretation. Foremost among these was the production and distribution of a quarterly newsletter, Tideline. A copy of each issue of the newsletter is included at the back of this narrative. Tideline was distributed to nearly 22,000 Bay area households, schools, businesses, churches, hospitals and libraries. It was considered to be our very best means of communicating our program schedules, announcements, news stories, advertisements and editorial comments. In fact, many of our programs were filled to capacity by Tideline recipients. The Tideline was used as a text at a training course for urban managers at the National Park Service's Training Center at Harper's Ferry in West Virginia. It was also used as a supplement to formal text books in many high school biology classes. We repeatedly get requests from biology teachers for subscriptions for that purpose.

Tideline was produced and edited by Volunteer Janis Tipton-King, who also serves as a Director of our cooperating association (see Section H.18). Our mailing list was managed by Volunteer Howard Collins, who coordinated 2,209 additions to the list, 585 deletions and 534 address changes. Without volunteer assistance, Tideline would not be possible.

Our October "Sale of Native Plants" drew 400 horticulturists to the Refuge.

Another non-traditional interpretive effort was the Refuge's seventh annual Spring Poster Contest, which attracted 2000 entries by artists in grades K-6 from the three local school districts. The contest theme this year was "Endangered Species."

First place winners in each grade won free passes for themselves and their parents to the Marine World/Africa USA. Second place winners and their parents won a trip to the San Francisco Zoo. Third place winners each won a pass for three to California Academy of Sciences in San Francisco's Golden Gate Park. All winners and honorable mentions received ribbons.

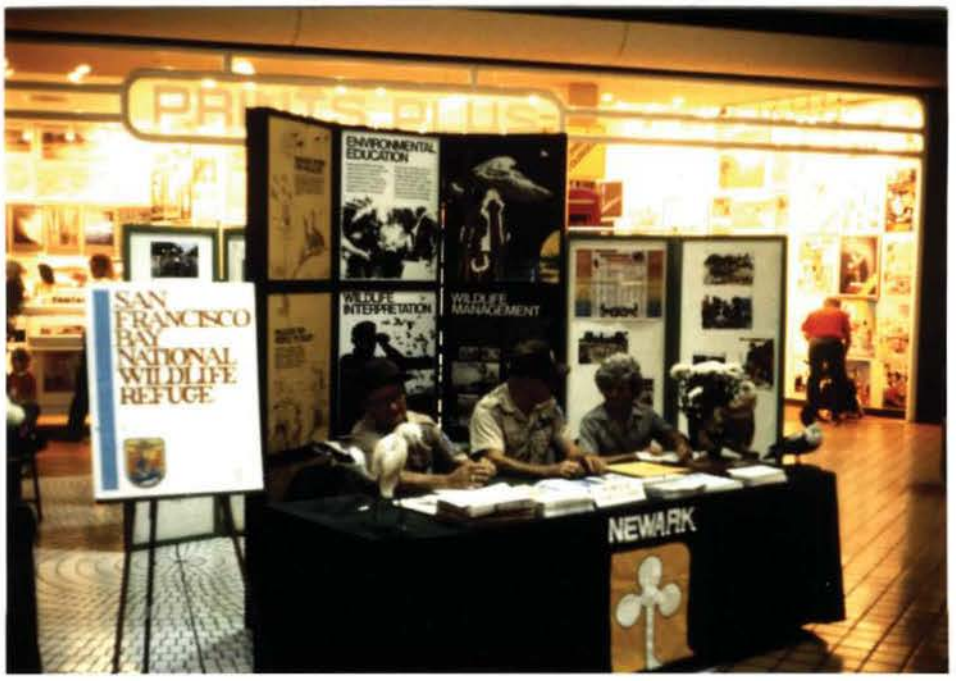
Some of the proud winners of our Endangered Species Poster Contest posed with their ribbons.

We feel that a poster contest is a good way to reach members of the public who might otherwise never make it to the Refuge. These students spent hours (days) preparing posters which advocated the preservation of San Francisco Bay and its wildlife. In the process, each artist may have convinced him/herself that a conservation endeavor is a worthwhile pursuit. This is difficult to measure, but, considering the persuasive, convincing nature of most of the posters, we feel that many advocates of our conservation ethic were either created or reinforced.

In addition, the awareness level of many South Bay students (as well as teachers and parents!) was heightened and many visitors checking in at the reception desk stated that their curiosity had been piqued by the contest, and they were here to see who we were and what we were all about.

Our second annual photography contest got underway in May. It was run in conjunction with our cooperating association and had good public response. The theme was "Picture Local Wildlife" and hundreds of local residents entered. The Grand Prize winner received an Alaska Safari, courtesy of Alaska Wildland Adventures. Other winners received whale watching trips, cross-country ski packages at Yosemite or photographic books. Thousands of visitors saw the display of winning photography and gained a new appreciation of our local wildlife.

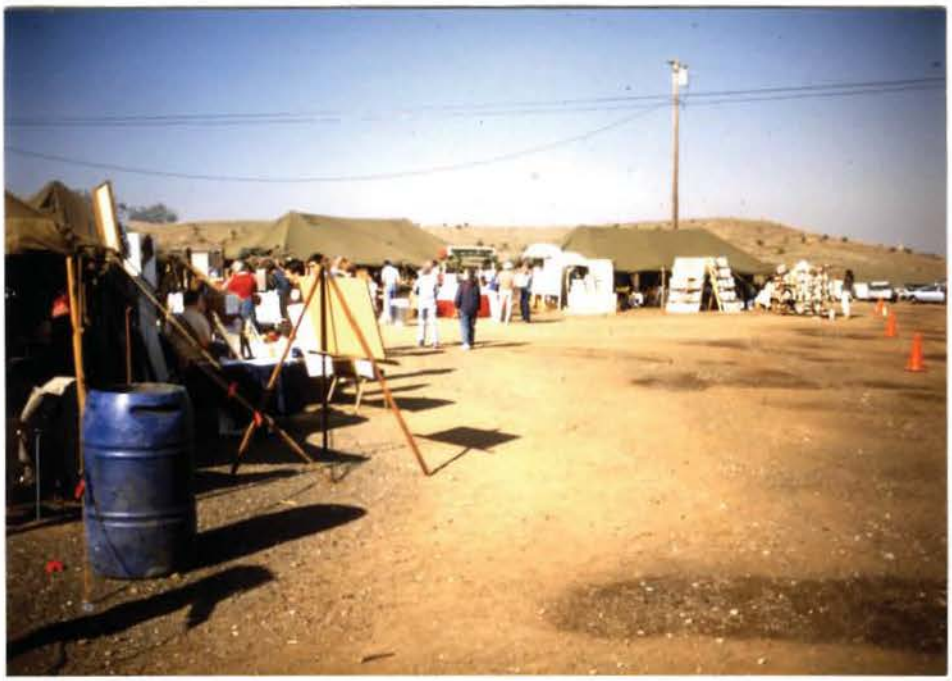
In spite of all of the efforts that we made during the year to contact the public, we know that there are many thousands of people out there whose interests do not include endangered species, wetland preservation, migration, waterfowl populations or anything else along those lines. Reaching these people is one of the most challenging tasks with which the interpretive staff is confronted. And the first step in reaching them is getting them out to the Refuge where they can see with their own eyes what sort of job we are doing.



Participation by volunteers in off-site community festivals is an effective way to promote the Refuge in our fast-paced, urban environs.

On 3 and 4 December, we held our seventh annual "Wildlife Arts and Crafts Show". Almost 5,000 Bay Area residents visited the show to purchase Christmas presents. Many people who would never have visited the Refuge spent the day here and learned about our programs.

Our Christmas Arts and Crafts Sale brought lots of hungry shoppers to the Refuge.



Three thousand people did their Christmas shopping at our annual art sale.

Due to remodeling of the Visitor Center and the resulting loss of floor space, we held the show outdoors for the first time. Tents were donated by the 23rd Marine Regiment, and 32 artists set up their booths and did great business. Fortunately, the weather was great all weekend long.

Our annual "Kid's Day" is great fun every year for kids of all ages.

Pumpkin carvers turned out in force during our Halloween Open House.

8. Hunting

With the walk-in area at Ravenswood closed again this year because of dike maintenance, the number of hunters using the Refuge was low. Approximately 1,500 hunters utilized the areas open to boat access only.

Shoveler, scaup and green-winged teal made up the majority of the bag, however the availability of birds this year was low due to duck numbers and Bay area weather.

9. Fishing

Public use of the access along the Dumbarton Point Trail (south end of the fishing pier) continued to increase. Use of the Dumbarton and Ravenswood Fishing Piers has greatly increased. Approximately 100,000 anglers used the piers in 1988.

Fishing from or near the piers has netted a variety of fish: leopard shark, sand shark, bat ray, shiner surfperch, bullhead, and the elusive striped bass and white sturgeon.

11. Wildlife Observation

The opportunity to view wildlife in its natural habitat attracts many of our visitors. In close proximity to the Visitor Center is salt marsh, slough, extensive mud flats, open water and upland coastal chaparral, grassland and trees. This range of habitats provides an ideal area for visitors to explore, alone or with our naturalists, when seeking local wildlife.

Some visitors participated in hikes, van tours or canoe trips to Mallard Slough and Triangle Marsh, where marsh-nesting and feeding birds were easily seen. Others were led by a naturalist to Dumbarton Marsh, where the endangered California clapper rail nests. Only when the salt marsh is flooded by a very high tide do these nearly flightless birds emerge from the protective vegetation. Bird watchers revel in these opportunities.

In addition, many nature study groups led field trips to our refuge, and the Audubon Society once again conducted its annual Christmas bird count here. One of the most popular sites for local bird watchers was the restored tidal area, Tract 102, where great numbers of shorebirds and migratory waterfowl gather to feed. There is also a peregrine falcon commonly sighted here.

17. Law Enforcement

The public safety unit operated with four full time officers for the first time since the Refuge opened to the public in 1980.

The goals of our public safety unit continues to remain the same: crime deterrence as a short-range goal and crime prevention as the long range goal. As our visitation increases at San Francisco Bay NWR and eventually at several of the satellites both of these goals will remain a challenge.

Patrolling is done selectively depending on previous incidents and the number of visitors using the area. Patrol activities in the North Bay were conducted by an assistant refuge manager with law enforcement authority. These patrols were limited mainly to weekdays while conducting other duties in the area.

A total of 27 Refuge permits were issued for controlled activities within 4 of the refuges in the Complex. Permits were issued for gathering biological data, Christmas bird counts, and access for construction activities and various media activities.

Vandalism occurred at a lower level than in 1987. Interpretive signs on the fishing piers and Tidelands trails were vandalized as were gates, fences and boundary signs. We estimate that our replacement costs were approximately $1,500.00 and labor cost associated with repairs and replacement was $1,400.00. An interpretive panel on the fishing piers was not replaced due to the cost.

In order to provide a response and coverage after hours, a call out list has been established for the four officers. Each officer covers a three month period. The list is provided to the security alarm service, local police and fire departments, U.S. Coast Guard and the U.S. Park Police.

Refuge officers contacted approximately 10,000 individuals and were involved in 167 incidents during 1988. An incident is an event that occurs on Service lands or is personally encountered by Service enforcement personnel during the course of official duty. Incidents in which the staff were involved are listed in the following tables.

Table 1

Uniform Crime Incidents

Inv. 17-01- Classification	Number	Arrest
05 Aggravated Assault (Refuge Officer)	1	
07 Larceny	1	
09 Simple Assault	1	
10 Arson	1	
11 Counterfeiting	1	
15 Vandalism	7	
19 Narcotics (Paraphernalia)	30	31
27 Suspicious Circumstances	2	
Total	44	31

Table 2

FWS Incidents

INV 5-01- Classification	Number
01 Person-Injured/Ill	1
07 Property-Found	4
08 Abandoned Property	2
11 Accident-Traffic	4
14 Animal Trespass	2
16 Assistance to Citizens	5
17 Assistance to other Organizations	25*
18 Unsecure Installation	16
Total	59

*Includes 13 arrests on warrants not included with other charges, and one on-view arrest for robbery, auto theft, grand theft and possession of stolen property.

During the performance of their regular duties, Public Safety Officers made a total of 13 felony arrests and 35 misdemeanor arrests. A total of $29,135 in state warrants and $5,000 in Federal warrants were served.

Officers issued a citation or made arrests for a total of 800 violations (441 state and 359 federal) this year. A total of $21,927 in fines were collected as follows: Federal court $10,976; State court $10,951. This compares to $33,321 collected in 1987.

Table 3

Federal Violations

Violation/Section	Guilty	Dismissed*	Pending	Total
Take Migratory Birds-MBTA:				
16 USC; 703			1	1
Duck Stamp:				
16 USC; 718A	3	0		3
Hunting Methods:				
50 CFR; 20.21b	1	0		1
Closed Season				
50 CFR; 20.22	1	0		1
Late Shooting				
50 CFR; 20.23	0	1	0	1
Possess Freshly Killed Bird				
50 CFR; 20.32	1	0		1
Trespass (Person)				
50 CFR; 26.21a	69	12	6	87
Trespass (Dog)				
50 CFR; 26.21b	7	0		7
Taking Plants/Animals				
50 CFR; 27.21a	1	0		1
Vehicles Violations				
50 CFR; 27.31	8	1	0	9
State Law Vehicle				
50 CFR; 27.31a	5	1	0	6
Careless Driving				
50 CFR; 27.31c	1	0		1
Speeding				
50 CFR; 27.31d	204	9	4	217
License Plates, registration				
50 CFR; 27.31f	1	0		1
Driver's License				
50 CFR; 27.31g	2		0	2
Parking				
50 CFR; 27.31h	0	2	0	2
Possession Firearms				
50 CFR; 27.41	4	1		5

Table 3 (Continued)

Federal Violations

Violation/Section	Guilty	Dismissed*	Pending	Total
Disturb Plants/Animals				
50 CFR; 27.51	2		0	2
Indecency				
50 CFR; 27.83	1	0		1
Interfere				
50 CFR; 27.84	2		0	2
Waste Disposal				
50 CFR; 27.94	3	1	0	4
Fire				
50 CFR; 27.95	1	0		1
Fish Without Licence				
50 CFR; 33.2a	1	2	0	3
Total	318	30	11	359

Warrants were obtained on persons failing to pay or appear. All federal warrants had a bail set at $5,000.00 per violation, regardless of the original violation or fine. A total of 14 ($5,000.00) warrants were issued ($70,000). By the end of the year, 8 warrants are still active and 6 violators had paid fines and those warrants were recalled.

An attempt to get the bail schedule revised was made. The federal magistrate sent a letter stating it was under revision and "fine tuning" of the schedule would be accomplished by the end of the year. As of this date no updated bail schedule is available.

The Refuge has a new high use fishing area located in Fremont. It is currently called the "Coyote Creek Lagoon" area. The current bail schedule does not include 50 CFR fishing violations. These violations will be included in the updated bail schedule, when it is completed. Violators are currently cited into State Court.

Table 4

State Violations

Violation/Section	Guilty	Pending	Dismissed	Warrant	Total
Hunting/fishing w/o license T14-700	36	15	5	19	75
Inland Water-2 Poles: F&G 2.05 T14-28.65a(bay)	9	5	1		15
Fishing gear-San Francisco Bay T14-28.65b	2		0		2
Undersized striped bass T14-27.85(c) T14-5.75(d)(1)(b)(2)	2	0			2
Over limit-striped bass T14-27.85(b)	1	0			1
Undersized sturgeon T14-5.80(c) T14-27.90	3	0			3
Overlimit - Fin Fish T14-27.60(a)	0	2	0		2
Take Dungeness crabs T14-29.85(a)(1)	6	1	0	1	8
Duck Stamp T14-510	0			2	2
Fish closed stream T14-8.05(1)(a)	1	0			1
Take protected birds F & G 3511	2		0		2
F & G 7360	1	0			1
F & G 7850	1	0		0	1
Littering w/in 150' of water F&G 5652	0		0	1	1
Fremont Municipal Code Shooting in City Limits 3-3106	0	2	0	0	2
Harbors & navigation code H & N 308	1	0	0	0	1
50 CFR 26.21a	1	0	0	0	1
Business & Professions Code	8		0	3	11
Health and Safety Code	37	10	3	8	58
CA Penal Code	15	5	2	1	23
CA Vehicle Code	81	129	7	12	229
Totals	207	169	18	47	441

Citations were written for a total of 115 Fish and Game violations in 1988. The Fish and Game citations resulted in $7,252 in fines, 1 year probation and 5 days in jail. Three violators were given suspended sentences. There are $2836.00 in warrants outstanding. Narcotics violations resulted in $4212.00 in fines, 21 1/4 years probation/diversion and 491 days in jail. There are $7870.00 in outstanding warrants. All other violations resulted in $13,330.00 in fines, 9 1/2 years probation, 230 days in jail and $12,750 in outstanding warrants.

18. Cooperating Associations

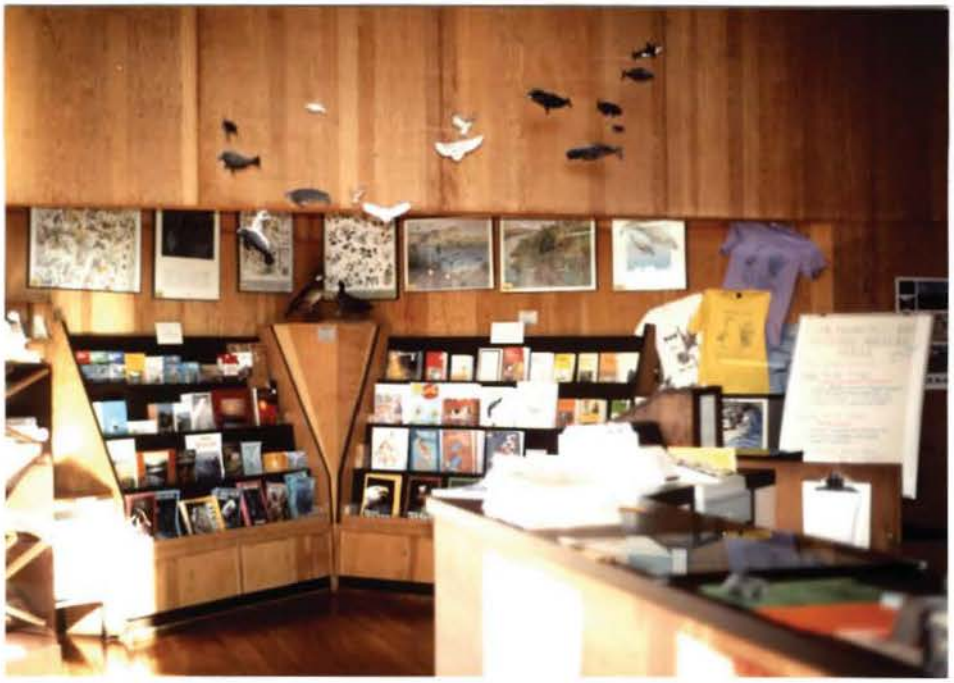
1988 was the first full year of operations for the San Francisco Bay Wildlife Society. This non-profit corporation has two objectives: to raise money, and then to spend it on environmental education projects at the Refuge.

Sandra Kinchen served as membership director for our cooperative association. As such, she administered a membership roster that grew to 450 by year's end.

We raised money in a variety of ways during fiscal year 1988. Wholesale and retail sales of books, pamphlets and theme-related items brought in $26,400.00. Membership dues, donations and interest amounted to $3,600.00: Our art show (Section H.7) netted another $27,000.00. Total receipts for the year: $33,000.00! We had to pay lots of bills from this amount, such as the purchase of the books that we sold ($15,000.00), but we still had enough net profit to print our Tidelines newsletter ($3500.00), throw a banquet for our volunteers ($2000.00), fund a petty-cash allotment for environmental education operating

costs ($1,000.00), and buy a computer, 20 pairs of binoculars, benches for students and lots of miscellaneous things such as dip nets, picture frames, 2 institutional-size coffee urns and 1000 paper cups, volunteer uniform items, postage stamps, stationary and so on.

San Francisco Bay Wildlife Society produced its first publication in 1988, and prepared to publish its second. A six-page species checklist of Bay area butterflies was printed and 600 copies were sold by year's end. A photographic history of Drawbridge, a ghost town located on the Refuge was written, and typesetting was underway at the end of the year. We expect this book to be a big seller, and to make a big impact on the environmental ethic of a new audience. Drawbridge became a ghost town when the salt marshes along the bay shore had been degraded to the point of no longer supporting large populations of waterfowl and shellfish. The inhabitants moved away, leaving scores of old cabins and hunting clubs behind to demonstrate the consequence of habitat destruction.



Our book sales area is located in the foyer of the Visitor Center. At year's end, plans were underway to expand our activities.

Donations are a minor, but growing source of money. The Society actively solicits contributions on our widely-distributed membership application printed in the Tideline newsletter. We also have a donations box in the Visitor Center. Finally, we request donations from corporations, which occasionally respond.

The last source of money for the Society is our Christmas Arts and Crafts Sale fund raiser. Thousands of visitors come to the Refuge for this annual event, and the cooperative association makes money from artists' registration fees, commission on art sales, a raffle and food service. The art show is described in detail in Section H.7.

We expanded San Francisco Bay Wildlife Society in 1988, opening a satellite sales outlet at Tulelake National Wildlife Refuge. Our volunteer staff handled ongoing administrative details, such as ordering books for the Tulelake outlet, and paying their bills.

Director Sandra Kinchen took charge of administering the Society memberships. She set up a membership booth at the art show and did land-office business for two days, signing up local citizens who wanted to contribute to a worthy cause. She continues to process applications, register new members, correspond with inquisitive potential members and handle the membership dues.

Our future during 1989 is clear. The Society will continue to grow and to finance the interpretive effort at San Francisco Bay National Wildlife Refuge. We will be actively involved in environmental education and wildlife interpretation, and will continue to seek out interested people from the community to lend a hand.

This is what San Francisco Bay Wildlife Society is all about - funding nature programs, involving the community, creating a wildlife refuge constituency. Such is the challenge, and the reward, of interpretation.

I. EQUIPMENT AND FACILITIES

1. New Construction

Using the Refuge's Gradall and a renter dozer, maintenance staff rehabilitated the old salt crystallizer ponds in Tract #102. This work is described in more detail in Section F.2 of this narrative.

2. Rehabilitation

A vacant Leslie Salt Company building which was transferred to the Refuge in 1983, received further rehabilitation as part of a long-term program to convert it into an environmental education facility. Maintenance staff built and installed large wall and upright cabinets to provide secure storage space for supplies. A Boy Scout troop built 18 stools for students' use in the building.

During the summer of 1988, the maintenance crew remodeled the refuge visitor center in preparation for the installation of new exhibits. Pat Koglin of the regional office was "detailed" here intermittently during the project to supervise and assist the maintenance crew.

Work done by USFWS staff included both the removal and construction of interior walls, construction of a projection booth and storage closet, installation of doors and windows, and construction of a "boardwalk" meandering through the new exhibit area. Contractors handled the electrical and duct work, and the

installation of new carpeting. (These alterations primarily effected the former auditorium and display areas; the visitor center lobby was left substantially unchanged.)

In September, Portland-based Promotion Products Inc. installed new exhibits in the visitor center, including several dioramas and two-dementional displays containing text, artwork and photographs. Of the old exhibits removed from the visitor center prior to remodeling, one was given to Sacramento NWR, four were given to the Josephine D. Randall Junior museum of San Francisco (a children's science museum), and one was re-used in the new visitor center.

3. Major Maintenance

Maintenance contract data for 1988 are as follows:

Heating System Maintenance Contracts for FY87 were:

Headquarters
George A. Fincer Amount: $1,460.00
14336 Wiley Street, San Leandro, CA
Environmental Education Center
G.J. Yamas Co., Inc. Amount: $1,636.00
#1 South Linden Ave.,S. San Francisco, CA

Janitorial Contracts for FY87 were:

Headquarters/Environmental Education Center
Nova Commercial Co., Inc. Amount: $11,472.00
321 Merrill Ave., Fremont, CA

The service was performed five days a week at the Headquarters and 3 days a week at the EEC.

Building Security Contract for FY88 were:

Headquarters/Environmental Education Center
Security General Amount: $5,916.00
848A Stewart, Sunnyvale, CA

Contracting for 10 portable toilets on the fishing piers was awarded to:

Acme & Sons Sanitation, Inc.
P.O. Box 1343, Campbell, CA

J. OTHER ITEMS

2. Other Economic Uses

Commercial harvest of brine shrimp in refuge salt ponds has occurred for over 20 years. In 1987 a competitive bid process was used to obtain fair market value for the brine shrimp (live and cysts) harvested from refuge salt ponds. Novalek Inc. of Hayward, CA was awarded the 5-year contract in December 1987.

The previous harvester, Bay Brands Inc. sued the Service for arbitrary and capricious award of the contract to another company. Litigation preparation and negotiations consumed a large part of 1988. Trial dates were postponed several times. In November 1988, possible settlement conditions were proposed. This settlement would close several refuge ponds from harvest, upstream of non-refuge ponds that were harvested by Bay Brands. It also provided for year-round access to refuge ponds independent of Bay Brands activity. The potential for conflict would be eliminated since both harvesting companies would be working in independent pond systems.

3. Credits

While the entire staff had input and assisted in roughing out this 1988 edition, the following staff members were responsible for the various sections as follows:

Sections A, B, C - all
Section E 1, 2, 5, 8 - Ben Crabb
Section E 4 - Sheila McCartan
Section D 5 - Kevin Foerster, David Lonzarich
Section E 6 - Bob Bolenbaugh
Sections F & G - Kevin Foerster
Section H 1 - John Steiner, Fran McTamaney
Section H 2, 3 - Fran McTamaney
Section H 4, 5, 6, 7, 9, 11, 12, 13, 14 16, 18 - John Steiner
Section H 8 - 9 - Jim Ferrier
Section H - 17 Bob Bolenbaugh, Barry Tarbet
Section I - Mike Bitsko.

Editing was done by Ben Crabb and Jean Takekawa. Typing was done by Kathy Zeliff, Joan Dawson and Jan Armigo Brown.

EXHIBIT 13

Management and Conservation of San Francisco Bay Salt Ponds: Effects of Pond Salinity, Area, Tide, and Season on Pacific Flyway Waterbirds

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Abstract.—Throughout the world, coastal salt ponds provide habitat for large numbers and diversities of waterbirds. San Francisco Bay contains the most important coastal salt pond complexes for waterbirds in the United States, supporting more than a million waterbirds through the year. As an initial step in attempting to understand how the anticipated conversion of salt ponds to tidal marsh might affect the Bay's bird populations, the number of birds using salt ponds on high and low tides was counted during the winter months of 1999/00 and 2000/01. Behavior and habitat use of birds in these ponds were assessed, and the effects of tide cycle, pond salinity, and pond area on bird use were examined. We recorded 75 species of waterbirds in surveys of salt ponds in the South Bay from September 1999 to February 2001, totaling over a million bird use days on high tide. Shorebirds and dabbling ducks were the most abundant groups of birds using the salt ponds. Waterbird numbers and diversity were significantly affected by the salinity of ponds in a non-linear fashion with lower numbers and diversity on the highest salinity ponds. With the exception of ducks and Eared Grebe (*Podiceps nigricollis*), tide height at the Bay significantly affected bird numbers in the salt ponds with ponds at high tides having higher numbers of birds than the same ponds on low tides. Considerable numbers of birds fed in the salt ponds on high and low tides, although this varied greatly by species. Habitat use varied by tide. Management recommendations include maintaining ponds of varying salinities and depths. Restoring salt ponds to tidal marsh should proceed with caution to avoid loss of waterbird diversity and numbers in San Francisco Bay.

Key words.—Salinas, solar ponds, waterfowl, shorebirds, waders, salinity.

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Coastal salt ponds (solar ponds, or salinas), areas where salt is extracted from salt water through solar evaporation, provide important nesting, foraging, and roosting habitat to waterbirds world-wide (Rufino *et al.* 1984; Sampath and Krishnamurthy 1989; Velasquez 1993; Masero and Pérez-Hurtado 2001). For instance, in Australia, three of the ten most important areas for shorebirds encompass commercial salt ponds (Lane 1987), while in Puerto Rico, the Cabo Rojo salt complex holds more shorebirds than any other site on the island and is one of the most important shorebird areas in the Caribbean (Collazo *et al.* 1995). Along the Pacific coast of North America, salt pond habitat supports significant numbers of waterbirds as recorded at critical Pacific Coast sites such as Laguna Ojo de Liebre, Baja California del Sur, Mexico (Page *et al.* 1997); San Diego Bay, California (Terp 1998); and San Francisco Bay, California (Page *et al.* 1999).

San Francisco Bay contains the most important salt pond complexes for waterbirds in the United States, supporting more than a million waterbirds through the year (Accurso 1992; Page *et al.* 1999; Takekawa *et al.* 2001). Single day counts of waterbirds in the salt ponds during winter months can exceed 200,000 individuals (Harvey *et al.* 1992), and single day counts during peak spring migration have exceeded 200,000 shorebirds in a single salt evaporation pond (Stenzel and Page 1988). The Bay and its surrounding salt ponds are significant habitat for waterbirds including Canvasback (*Aythya valisineria*) (Takekawa and Marn 2000), Ruddy Duck (*Oxyura jamaicensis*) (Miles 2000) and a number of shorebird species (Stenzel and Page 1988), including the Pacific Coast population of

Snowy Plover (*Charadrius alexandrinus*) which is considered threatened by the U.S. Fish and Wildlife Service (Page *et al.* 1991).

Commercial salt ponds in San Francisco Bay have existed for over a century (Ver Planck 1958). Prior to European settlement, perhaps 800 ha of natural salt crystallizing ponds were found primarily in southern reaches of the Bay. A series of these ponds of about 400 ha were farmed for salt by the native Yrgin tribe (Goals Project 1999). Beginning with European colonization around the mid 1800s, extensive diking of tidal wetlands occurred to create salt ponds (Josselyn 1983), with accelerated conversion of tidal marsh to salt ponds from the 1930s through the 1950s (Goals Project 1999). Presently, there are over 12,000 ha of salt ponds in San Francisco Bay (Goals Project 1999), most in the south region of the Bay where this study is focused.

Despite the documented occurrence of large numbers of waterbirds in San Francisco Bay salt ponds, comprehensive published studies of the role salt ponds play in maintaining waterbird diversity and numbers in San Francisco Bay are lacking. Presently, there is considerable interest in turning over the commercially operated salt ponds to state and federal wildlife agencies for restoration to tidal marsh, a habitat that has decreased by 80% in the Bay during the past 150 years (Goals Project 1999). We believe that part of this restoration emphasis is driven by a public misconception of salt pond habitat as being less valuable to wildlife since it is "man-made". As an initial step in understanding the effect of restoring salt pond habitat to tidal marsh habitat on the Bay's waterbirds, we evaluate the importance of salt ponds as roosting and feeding sites for migrant and wintering waterbirds, and examine the effects of abiotic variables, such as tide cycle, pond salinity, and pond area, on bird use of salt ponds.

METHODS

Study Area

We surveyed 22 salt ponds in the South Bay, the area of San Francisco Bay south of the San Mateo Bridge (Fig. 1). Nine salt ponds were surveyed during the 1999-2000 season (hereafter called the 1999 season) and 19 during the 2000-2001 season (hereafter called the 2000 season, six of these ponds were also surveyed the previous year, Table 1). Cargill Salt Company managed almost all evaporation ponds we surveyed for salt production. Ponds ranged from 17 ha (Pond N4S) to 175 ha (Pond N3), and from mean salinities (parts per thousand, ppt) of 25 ppt (Pond A9) to 259 ppt (Pond PP1, Table 1).

Study Period and Census Technique

Although salt ponds are non-tidal, ponds were surveyed twice in a day; once on a high tide greater than 1.2 m and once on a low tide less than 0.8 m. This was done since there is an exchange of some birds with the nearby bay, driven by the tidal cycle.

The 1999 survey season extended from late October 1999 through February 2000. Each pond was surveyed at high and low tide during this period, including three times from late October through December and three times January through February.

During the 2000 season, from September 2000 through February 2001, ponds were also surveyed twice in a day on high and low tide. However, on 13 occasions inclement weather prevented the completion of one of the paired censuses, and they were completed within three days of the first census. We attempted to survey each of these ponds twice per month with at least one tide cycle passing between censuses of the same pond. On five occasions, we were unable to complete the planned surveys due to inclement weather during surveys of ponds A4, A16, and A9. An additional five ponds were selected to be surveyed once a month only during high tide to increase our survey efforts (Table 1).

Spotting scopes with 20×60 zoom lenses and 8×35 binoculars were used to identify birds to species with the exception of Long-billed and Short-billed Dowitcher (*Limnodromus scolopaceus* and *L. griseus*), which were grouped as dowitchers because of the difficulty in distinguishing these species during winter. Rarely, if birds were too distant to identify to species, they were recorded as unidentified shorebird, gull, duck, or other bird group (see below for list). For most analyses, species were grouped into either: 1) dabbling ducks; 2) diving ducks that are not fish-eaters (including Pied-billed Grebe, *Podilymbus podiceps*); 3) Eared Grebe (*Podiceps nigricollis*); 4) fish-eating birds including all herons, egrets, mergansers and *Aechmophorus* grebes; gulls and terns; 5) shorebirds; or 6) landbirds (including raptors). Birds that could not be assigned to a group were not used in analyses. During each census, complete counts were made of all birds using each pond. Large ponds or ponds with a large number of birds were surveyed by at least two people. Each bird was counted individually when possible; however, large flocks were estimated by counting in groups of 5, 10, 20, 50 or 100.

For a particular pond, data recorded for birds included species, behavior, microhabitat, and number of individuals if more than one individual was exhibiting the same behavior in the same habitat at the same time. For analyses, behavior was characterized as either Foraging (feeding, swimming, and diving behaviors) or Non-foraging (all other behaviors). Micro-habitats were defined as 1) Island: island of dry substrate which could not be covered by water in a strong wind; 2) Man-made: structure such as dikes, roads, pilings, boardwalks etc.; 3) Mud: mudflat (dry or wet) or shallow water less than

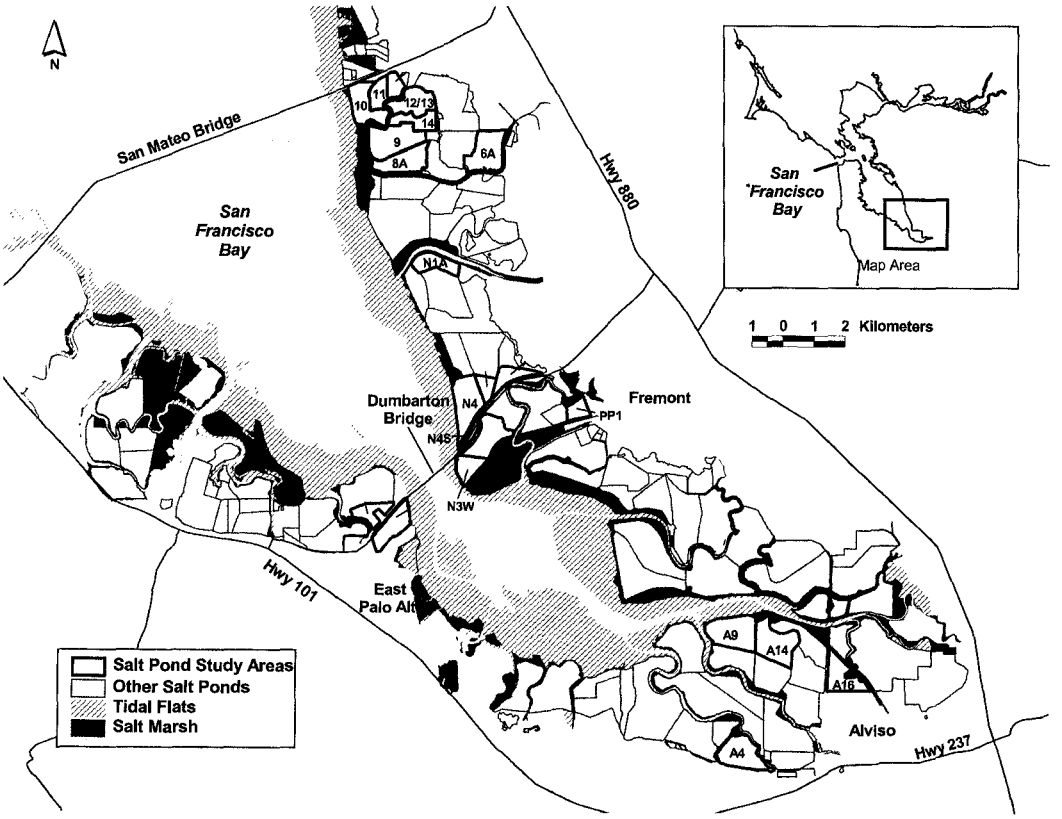

Figure 1. Map of south San Francisco Bay including salt ponds. For more information on ponds see Table 1.

10 cm deep; and, 4) Water: open water greater than 10 cm. The date, tide, pond number, observer, start and end time were also recorded for each census.

On each day that a pond was surveyed, 2-4 salinity measurements spread around the pond were recorded (see Table 1 for total number of salinity measurements taken per pond during the study period). A telescoping pole with a small jar on the end was used to sample water from the surface of the pond. To generate salinity measurements, we took the temperature of our water sample with a digital thermometer, and we measured the specific gravity of the sample with one of four hydrometers ranging from a specific gravity of 1.00 for the freshest water to a specific gravity of 1.25 for the most saline water; these were then converted to ppt. All samples were measured in the field at the time of collection. Because of fluctuations in pond salinities that occurred after heavy rain, extra measurements were taken during those periods.

Statistical Analyses

Frequencies of foraging and non-foraging of birds (grouped by foraging style) in salt pond habitats on high and low tides were analyzed using the χ^2 test (Snedecor and Cochran 1967). Linear models were used to test for effects on total number of birds, as well as number of waterbird species (species richness), using salt ponds. We fitted the same models to all birds and to each of the seven species groups of birds. Effects included year (1999, 2000); month (September-February); area of pond (ha); tide (high and low); salinity (average salinity of pond, ppt) and pond. The dependent variable, number of birds, was log transformed, and the other dependent variable, species richness, was square root transformed in order to conform with assumptions of linear models (normality and homoscedasticity). Species richness was calculated as the number (or mean number in cases where two surveys were done on the same pond in the same month and tide) of waterbird species counted at the same pond in the same year, month, and tide. Salinity, area, and month were treated as quantitative variables. Salinity and month were fitted as quadratic functions since there was evidence that they were non-linear effects. Species richness analyses were weighted by the number of censuses (N = 1 or 2) that were conducted at a given pond in the same year, month, and tide. We tested for unequal variances among groups (heteroscedasticity; Sokal and Rohlf 1981) with the Cook-Weisberg test (test hettest, StataCorp. 1999. Release 6.0, College Station, TX) using fitted values of the variable representing number of birds or species richness. When there was evidence of heteroscedasticity, violating models were rerun using ordinal logistic regression (test ologit, StataCorp. 1999). To run this model, number of birds was grouped into four categories representing the 0-25%, 26-50%, 51-75%, and 76-100% quartiles of the total number of birds.

Table 1. Waterbird surveys of San Francisco Bay saltponds, 1999-2001. Given are pond identification, pond area, number of surveys conducted at high and low tides, and mean pond salinity (ppt ± SD (N subsamples)). See Fig. 1 for location of ponds. Areas of ponds calculated from version 1.50b4 of EcoAtlas (San Francisco Estuary Institute 2000).

Salt pond	Area (ha)	Oct. 1999-Feb. 2000			Sept. 2000-Feb. 2001		
		High tide	Low tide	Salinity	High tide	Low tide	Salinity
10	105				6		31 ± 4 (24)
11	49				12	12	40 ± 10 (47)
12/13	98				12	12	47 ± 8 (49)
14	65				6		64 ± 12 (27)
6A	133				6		68 ± 8 (25)
8A	109				12	12	137 ± 35 (62)
9	151				12	12	108 ± 20 (54)
A14	142				11	11	83 ± 10 (44)
A16	97				12	11	71 ± 6 (44)
A4	124				12	11	39 ± 4 ± (42)
A9	150				11	11	25 ± 3 (44)
B1	38				5		49 ± 23 (18)
N1A	70	6	6	58 ± 5 (26)	12	12	69 ± 6(44)
N3	175				6		216 ± 16 (26)
N3W[a]	58	6	6	155 ± 17[b] (25)			
N4	137	6	6	73 ± 9 (33)	12	12	149 ± 12 (54)
N4S	17	6	6	80 ± 10[b] (29)			
N6	38	6	6	57 ± 5 (25)	12	12	112 ± 5 (48)
N9	55	6	6	54 ± 28 (28)	9	9	108 ± 3 (36)
PP1	40	6	6	186 ± 27 (29)	12	12	259 ± 15 (48)
R2	57	6	6	199 ± 40 (37)			
SF2	98	6	6	171 ± 29 (35)	12	12	257 ± 14 (51)

[a]west side of Pond N3, area of his pond included in the area of N3.
[b]salinity not measured in October.

RESULTS

Abundance and Diversity

We recorded 75 species of waterbirds in surveys of salt ponds in the South Bay from September 1999 to February 2001. In 1999, 51 species of waterbirds totaling 136,900 birds were recorded on 54 high tide counts, and 44 species totaling 49,600 birds were recorded on 54 low tide counts. In 2001, 69 species of waterbirds totaling 919,900 birds were recorded on 192 high tide counts, and 65 species totaling 283,700 birds were recorded on 161 low tide counts. A significant difference in the total number of birds counted in the different groups of waterbirds was found between high and low tides ($\chi^2_7 = 33{,}645$, $P < 0.001$; Fig. 2). Shorebirds were the dominant group on the high tide, followed by dabbling ducks. This order was reversed on the low tide with no change in order among the other groups of birds. In both years, on high and low tides, the ten most numerous species accounted for over 85% of all birds counted (Table 2). In both years, the five most numerous waterbird species on the high tide stayed the same and consisted mainly of shorebirds, while the order and species varied between years for the most numerous waterbird species on the low tide (Table 2).

Dunlin (*Calidris alpina*) and Western Sandpiper (*C. mauri*) were the most abundant shorebird species (35% of all the birds counted) found in the salt ponds, followed by Willet (*Catoptrophorus semipalmatus*), American Avocet (*Recurvirostra americana*), and Black-bellied Plover (*Pluvialis squatarola*). Northern Shoveler (*Anas clypeata*) accounted for 18% of all the ducks and grebes counted.

All models examining factors potentially affecting numbers of birds using salt ponds

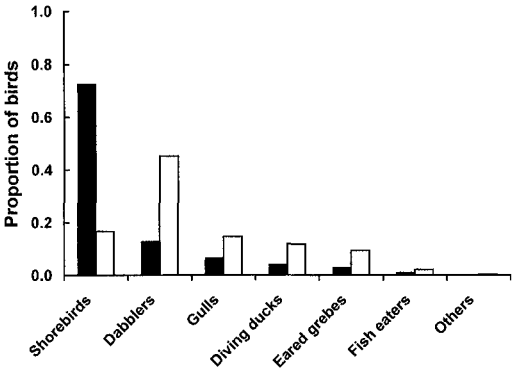

Figure 2. Proportion of all birds counted in south San Francisco Bay salt ponds by bird group and tide. Numbers combined for 1999/00 and 2000/01. Bird groups include: Shorebirds; Dabbling ducks; Gulls (include gulls and terns); Diving ducks; Eared Grebes; Fish eating birds (including waders, mergansers and grebes other than Eared Grebes); and Others (landbirds and raptors). Dark column = high tide, white column = low tide.

in the South Bay were highly significant (Table 3). Four models, including all birds combined, fish eating birds, landbirds, and shorebirds, violated assumptions of equal variances. However, patterns of significance stayed the same for those models using the alternative ordinal logistic regression model with the following exceptions: fish-eating birds—the effect of area went from non-significant ($P = 0.09$) to significant; shorebirds - the effect of area went from significant ($P < 0.001$) to non-significant; and, landbirds—the effect of tide went from non-significant ($P = 0.14$) to significant (Table 3). The individual salt pond where birds were counted explained significant amounts of variation, and this was the only variable that was significant for all models. Pond salinity, modeled as a quadratic function, explained significant amounts of variation in all bird groups with the exception of the landbird group. Models examining the numbers of dabbling ducks, diving ducks, and Eared Grebe all were similar in that month of study, pond salinity, and pond explained significant amounts of variation, while tide, pond area, and year of study (with the exception of the Eared Grebe model) did not. Significant year effects were found only for the Eared Grebe and gull models. All predictor variables were significant in explaining gull and tern numbers while none of the selected variables explained significant amounts of variation in landbird numbers, except tide and pond. For shorebirds, numbers decreased on low tides (high tide: mean number census^{-1} = 3136 birds ± 6810 SD, N = 246 censuses; low tide: mean number census^{-1} = 259 birds ± 580 SD, N = 215 censuses). For all birds combined, year of study did not affect numbers of birds. Combining years, mean number of birds (using only high tide counts) grew from September (mean = 2229 ± 2236 SD birds, N = 17 ponds) into October, peaked in October (mean = 6093 ± 10,620 SD birds, N = 20 ponds), fell slightly in November (mean = 5233 ± 6556 SD birds, N = 28 ponds) and remained relatively stable December through February (means ranged from 4044-4532 birds per month in this period, 28 ponds surveyed per month). High tide counts held significantly more birds than those at low tide (high tide: mean number census^{-1} = 4300 birds ± 6780 SD, N = 246 censuses; low tide: mean number census^{-1} = 1556 birds ± 2362 SD, N = 215 censuses). Holding the effects of pond, year, month, tide, and pond area constant, the largest number of waterbirds occurred at 140 ppt salinity as estimated by the fitted quadratic equation (Fig. 3).

Species richness of waterbirds showed similar patterns of significance as overall bird numbers (Table 4), with the one exception that species richness also showed a significant year effect. Species richness of waterbirds was significantly related to non-linear effects of month and salinity. Mean number of species, combining years (using only high tide counts), grew from September (mean = 12.6 ± 4.9 SD species, N = 17 ponds surveyed) and leveled off from October through February (means ranged from 14.9-16.3 species per month in this period, 20-28 ponds surveyed per month). Holding the effects of pond, year, month, tide, and pond area constant, the largest number of waterbird species occurred at 126 ppt salinity as estimated by the fitted quadratic equation (Fig. 4).

Species richness was positively related to pond area, was higher in the second year of study, and was greater on high tides than low

Table 2. Ten most abundant waterbird species recorded in salt ponds of south San Francisco Bay during autumn and winter on high and low tides. Percent total = (number of particular species/total number of birds) × 100.

	1999/2000		2000/2001	
	Species	Percent total	Species	Percent total
High Tide	Dunlin	26	Dunlin	31
	Western Sandpiper	16	Western Sandpiper	24
	Northern Shoveler	16	Northern Shoveler	13
	Willet	14	Willet	7
	American Avocet	8	American Avocet	6
	Black-necked Stilt	5	Black-bellied Plover	5
	California Gull[a]	4	Herring Gull[b]	4
	Black-bellied Plover	4	Marbled Godwit	4
	Least Sandpiper	4	Ruddy Duck	3
	Marbled Godwit	4	Eared Grebe	3
Total number		118,300		788,900
Low Tide				
	Northern Shoveler	41	Northern Shoveler	46
	American Avocet	12	Eared Grebe	11
	Bonaparte's Gull	11	Ruddy Duck	9
	Black-necked Stilt	10	Herring Gull	8
	Eared Grebe	7	American Avocet	7
	Ruddy Duck	6	Black-necked Stilt	5
	California Gull	5	Bonaparte's Gull[c]	5
	Bufflehead[d]	4	American Wigeon[e]	4
	Dunlin	2	Canvasback	3
	Least Sandpiper	2	California Gull[b]	3
Total number		47,200		249,100

[a]Herring Gull (*Larus argentatus*); [b]California Gull (*L. californicus*); [c]Bonaparte's Gull (*L. philadelphia*); [d]Bufflehead (*Bucephala clangula*); [e]American Wigeon (*Anas americana*).

tides (species richness, mean ± SD; 1999, high tide, 13.7 ± 6.3 species; 1999, low tide, 9.3 ± 4.6 species; 2000, high tide, 15.9 ± 7.0 species; 2000, low tide, 10.5 ± 6.9 species).

Behavior

Major behavioral patterns exhibited by birds using salt ponds in south San Francisco Bay consisted of foraging and roosting (Table 5, see Methods for list of other behaviors recorded). Combining roosting and other behaviors for all birds, the frequency of foraging behavior varied significantly between 1999 and 2000 on high and low tides (high tide, $\chi^2_1 = 70.9$, $P < 0.001$; low tide, $\chi^2_1 = 33.2$, $P < 0.001$; Table 5). There was no significant difference in the frequency of feeding behavior vs. roosting and other behaviors (combined) between tides in either year (1999, $\chi^2_1 = 0.1$, n.s.; 2000, $\chi^2_1 = 0.24$, n.s.; Table 5). However, considerable variation exists in the frequency of foraging behavior in salt ponds between tides within different groups of waterbirds (Fig. 5). For instance, within shorebirds, Marbled Godwit (*Limosa fedoa*), Black-bellied Plover, and Long-billed Curlew (*Numenius americanus*) were rarely observed foraging in the salt ponds on high tides, while other species such as Least Sandpiper (*Calidris minutilla*), Black-necked Stilt (*Himantopus mexicanus*), and American Avocet commonly foraged. At low tide, the majority of shorebirds found in the salt ponds were feeding (Fig. 5).

Effects of Microhabitat

Use of habitats within salt ponds varied for foraging and roosting birds (Fig. 6). In general, foraging birds were found most on moist to wet soils and on the water, and least on islands and other man-made structures. Roosting birds made more use of islands and

Table 3. Results of linear models examining effects on numbers of birds using salt ponds in south San Francisco Bay. Models include all birds; dabbling ducks; diving ducks that are not fish eaters including Pied-billed Grebes; Eared Grebes; fish eating birds including all herons, egrets, mergansers, and *Aechmophorus* grebes; gulls and terns; shorebirds; and landbirds including raptors. Response variable is number of birds counted (log transformed). Effects are year (1999/00, 2000/01), month (September-February analyzed as a quadratic), area = area of pond (ha), tide (high and low), salinity (average salinity of pond per month analyzed as a quadratic), and pond. Salinity, area, and month were treated as quantitative variables. N = 457 surveys.

	df	All birds	Dabbling ducks	Diving ducks	Eared Grebes	Fish-eating birds	Gulls and terns	Shore-birds	Landbirds[a]
Model	27	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$
Year	1	n.s.	n.s.	n.s.	$P < 0.001$	-[b]	$P < 0.001$	n.s.	-[b]
Month[c]	1	$P < 0.001$	$P < 0.01$	$P < 0.001$	$P < 0.001$	n.s.	$P < 0.001$	n.s.	n.s.
(Month)^{2}[d]	1	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	n.s.	$P < 0.001$	n.s.	n.s.
Area	1	$P < 0.001$	n.s.	n.s.	n.s	$P < 0.001$	$P < 0.001$	n.s.	n.s.
Tide	1	$P < 0.001$	n.s.	n.s.	n.s.	$P < 0.001$	$P < 0.01$	$P < 0.001$	$P < 0.01$
Salinity[c]	1	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	n.s.
(Salinity)^{2}[d]	1	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	n.s.
Pond	20	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.001$
R^2		0.29	0.69	0.70	0.75	0.46	0.59	0.34	0.11

[a]Models for which Cook-Weisberg test scores for heteroscedasticity of linear models at $P < 0.05$; models rerun using ordinal logistic regression (test Ologit, StataCorp. 1999) and Ologit test values reported. Pseudo R^2 reported for these models.

[b]Convergence of the model not achieved with year included, so model run without year as a variable.

[c]Linear term in the presence of a quadratic term.

[d]Quadratic term in the presence of a linear term.

man-made structures although many birds still roosted on moist-wet soils and on the water (Fig. 6). Of the birds that were foraging and roosting, the frequency of birds using different habitats on the high tide differed significantly from that on low tide (high tide, $\chi^2_3 = 237$, $P < 0.001$; low tide, $\chi^2_3 = 219$, $P < 0.001$). For birds observed foraging at high tide, 58% of the birds were seen using mud habitat and 38% water, while on the low tide 41% used the mud habitat and 56% used the water (Fig. 6). For roosting birds, while mud was the most frequently used habitat (38%) on the high tide, man-made structures were the most frequently used habitats (31%) on the low tide.

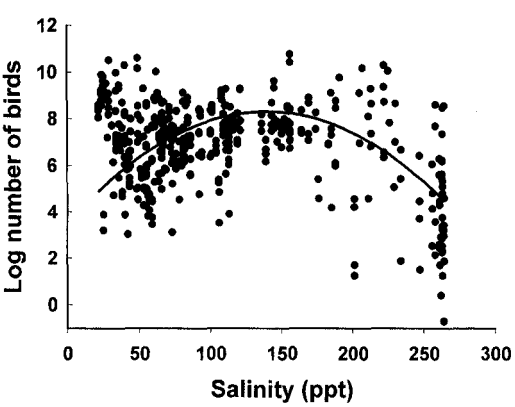

Figure 3. Relationship of bird numbers to salinity (ppt) in south San Francisco Bay salt ponds, 1999 and 2000. Number of birds log transformed. Best-fit quadratic function of numbers of birds depicted, controlling for effects of month, year, tide, pond, and pond area (see Table 3).

DISCUSSION

Abundance and Diversity

This study confirms the importance of San Francisco Bay salt ponds as foraging and roosting habitat to a large number and high diversity of migrant and wintering birds, especially shorebirds, ducks, gulls, and grebes (over 98% of all birds counted), and as such, supports the findings of others who have examined bird use of San Francisco Bay salt ponds (Anderson 1970; Swarth *et al.* 1982; Harvey *et al.* 1992; Takekawa *et al.* 2001). Annual bird use of salt ponds during this study period (calculated in bird days) numbered in the millions, supporting the existing designation of San Francisco Bay as a site of Hemispheric importance to shorebirds (a

Table 4. Results of linear model examining effects on numbers of species of waterbirds (species richness) using salt ponds in south San Francisco Bay, California. Waterbirds include dabbling ducks, diving ducks, grebes, herons, egrets, mergansers, gulls, terns, and shorebirds. Species richness square root transformed. See Table 3 for description of effects. df = numerator df of F test; residual df = denominator df of F test. Adjusted R^2 of model = 0.81.

Source	df	F	P
Model	27	42.6	$P < 0.001$
Year	1	8.6	$P < 0.01$
Tide	1	159.0	$P < 0.001$
Area	1	40.1	$P < 0.001$
Month[a]	1	15.0	$P < 0.001$
$(Month)^2$	1	12.7	$P < 0.001$
Salinity[a]	1	23.1	$P < 0.001$
$(Salinity)^2$	1	61.0	$P < 0.001$
Pond	20	18.6	$P < 0.001$
Residual	238		

[a]Effect of linear term in the presence of a quadratic term.

site supporting >500,000 shorebirds in a given year, Harrington and Perry 1995), as well as a major Pacific Flyway wintering and stopover site for ducks (Accurso 1992), grebes, and gulls (Harvey *et al.* 1992). During two years of salt pond surveys, we recorded 75 species of waterbirds, compared to 55 species found by Anderson (1970) in five salt ponds, and 70 species found by Swarth *et al.* (1982) in approximately 14 salt ponds. This difference probably reflects the greater number of ponds that we surveyed. In other parts of the world, high species diversity of waterbirds in coastal salt ponds has been recorded as well, ranging from 35 to 56 species (Britton and Johnson 1987; Martin and Randall 1987; Sampath and Krishnamurthy 1989; Velasquez 1993).

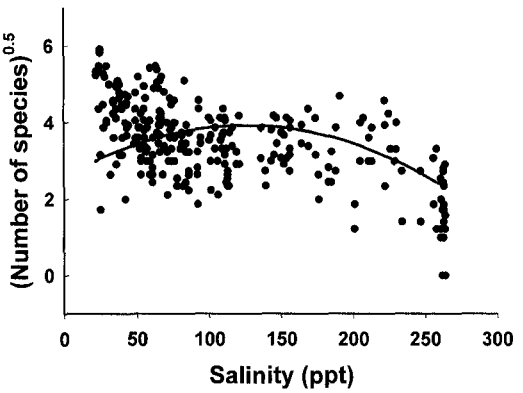

Figure 4. Relationship of waterbird diversity to salinity (ppt) in south San Francisco Bay salt ponds, 1999 and 2000. Number of waterbird species square-root transformed. Best-fit quadratic function of waterbird species number depicted, controlling for effects of month, year, tide, pond, and pond area (see Table 4).

Shorebirds were the most abundant group of waterbird in the salt ponds, as has been documented in other habitats of the Bay (Stenzel and Page 1988), and along the Pacific Coast of the United States (Page *et al.* 1999). Of the shorebirds using South Bay salt ponds, calidrid sandpipers were most abundant, a pattern similar to other parts of the world (Velasquez and Hockey 1992; Collazo *et al.* 1995). Next to shorebirds, dabbling ducks dominated, especially Northern Shoveler, followed by diving ducks and Eared Grebe. This corroborates the findings of Accurso (1992) who found the Northern Shoveler to be the most abundant dabbling duck in San Francisco Bay with 89% of them counted in the salt ponds of the South Bay.

We found a significant non-linear effect of month on numbers of birds and species richness with mean highest numbers and diversity for our autumn and winter study period in October and November. Waterbird species are still migrating through San Francisco Bay from September through November (Swarth *et al.* 1982; Accurso 1992), the early months of this study. Dunlin, the most abundant shorebird species in this study, are the latest autumn migrants, first occurring in any numbers in October (Shuford *et al.* 1989; Warnock and Gill 1996). Using our overall model, year differences were not

Table 5. Proportion of feeding, roosting, and other behavior of birds seen during salt pond surveys in south San Francisco Bay. N is the number of groups of birds observed engaged in a behavior in a pond at the same time (see Methods for more details).

	High tide		Low tide	
	1999	2000	1999	2000
Feed	0.53	0.44	0.54	0.44
Roost	0.43	0.46	0.37	0.39
Other	0.04	0.09	0.09	0.17
N	2,945	9,315	1,082	4,273

detected in numbers of birds, but we did find significant year differences in species richness. This may be partly due to our increased survey effort in the second year of the study resulting in finding more species not commonly found at salt ponds.

Tidal differences accounted for significant variation in numbers and species richness of waterbirds using San Francisco Bay salt ponds, contrary to Anderson's (1970) observations based on a limited number of ponds. Shorebirds, in particular, responded to the tide cycle, with high numbers using the ponds on high tide and lower numbers on the low tide. This fits similar patterns found at San Francisco Bay within species of shorebirds (i.e., Western Sandpiper; Warnock and Takekawa 1995, 1996) and among species (Swarth *et al.* 1982) where birds moved from salt ponds to adjacent tidal mudflats in great numbers to feed (Stenzel *et al.* 2002). In other parts of the world, similar patterns are seen with most shorebird species moving from salt ponds to tidal flats to feed (Velasquez *et al.* 1991; Masero *et al.* 2000). There are a few exceptions to this pattern within the shorebirds, notably the American Avocet and Black-necked Stilt. These species, especially the Black-necked Stilt, often stay in the salt ponds through the tide cycle, a pattern clearly seen during recent radiotelemetry studies in San Francisco Bay (PRBO, unpubl. data), and also observed in salt ponds of San Diego, California (Terp 1998). During winter months in South Africa, the shorebirds showing a positive affinity to salt ponds through the tide cycle included the Pied Avocet (*Recurvirostra avosetta*) and the Black-winged Stilt (*Himantopus himantopus*) (Velasquez *et al.* 1991). While fish-eating birds and gulls responded to the tide cycle in a similar way to shorebirds, duck and Eared Grebe numbers changed little between high and low tide, indicating that they stayed in the ponds through the tide cycle.

Undoubtedly, changes in bird use of salt ponds in response to tidal height are related, in part, to differing prey communities among different types of habitats and densities of birds. Masero and Pérez-Hurtado (2001), suggest wintering Redshank (*Tringa totanus*) in Spain move from salt ponds to tidal areas to feed not because food supplies are better, but because densities of foraging competitors are lower. Studies comparing food resources available to birds on tidal mud flats vs. in salt ponds are needed in San Francisco Bay.

In South Africa, Velasquez (1993) found that highest foraging densities of waterbirds were in salt ponds of 25-70 ppt salinity and 170-220 ppt salinity. Combining all waterbird species and controlling for various effects, we found highest numbers of birds in salinities around 140 ppt and highest species diversity in salinities around 126 ppt. This non-linear effect of salinity on numbers and diversity of waterbirds undoubtedly relates to prey diversity. For invertebrates, species richness declines with increasing salinity (Britton and Johnson 1987; Williams *et al.* 1990), but for invertebrate biomass, this is not a linear effect. Highest densities of important waterbird prey species in San Francisco Bay, the Franciscan Brine Shrimp (*Artemia franciscana*, often called *A. salina*; Larsson 2000), the Reticulated Water Boatman (*Trichocorixa reticulata*) and brine flies (*Ephydra* spp. and *Lipochaeta slossonae*), occur in salinities of 60-200 ppt (Carpelan 1957; Larsson 2000; Maffei 2000a, b). These invertebrate species are targeted by

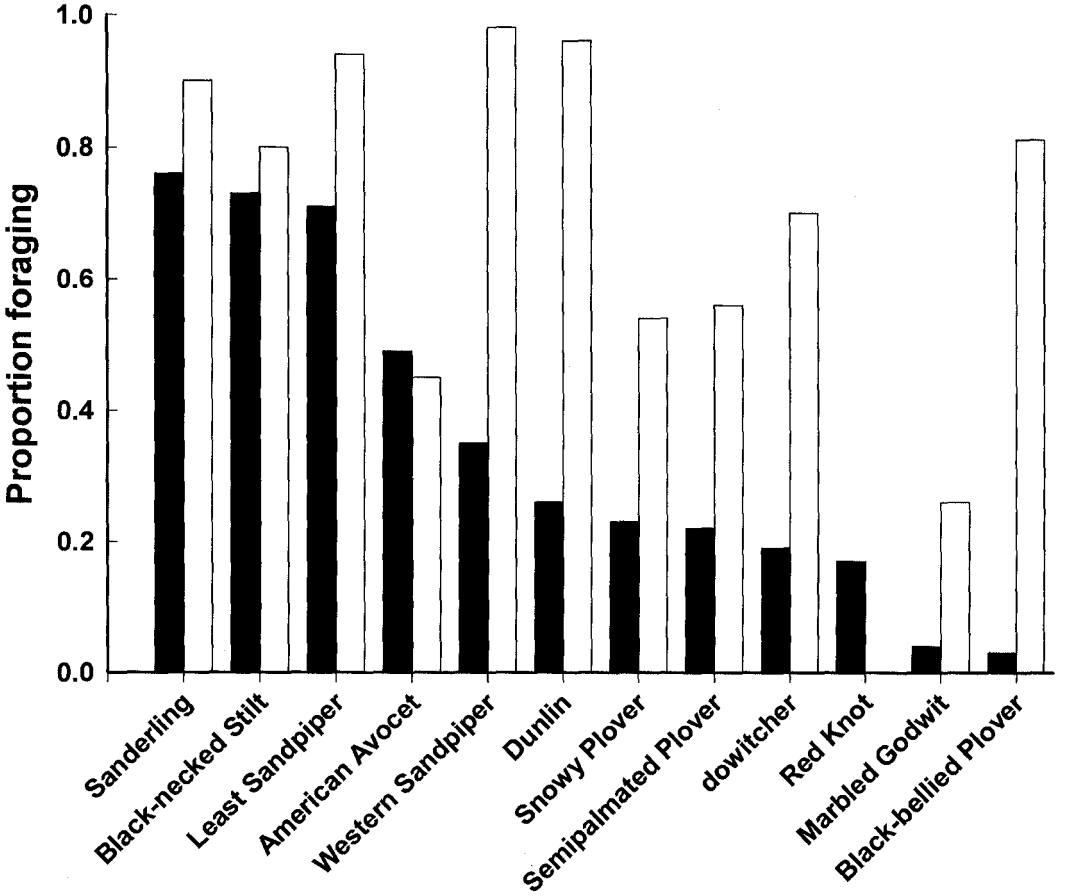

Figure 5. Proportion of most abundant shorebirds seen foraging on high and low tides in salt ponds of south San Francisco Bay. Numbers combined for 1999 and 2000. Dark column = high tide, white column = low tide. Semipalmated Plover (*Charadrius semipalmatus*), Red Knot (*Calidris canutus*), Sanderling (*C. alba*).

many waterbird species, especially the numerically abundant shorebirds and waterfowl (Anderson 1970). Swarth *et al.* (1982) found a strong positive correlation between numbers of Eared Grebe and invertebrate biomass in eleven South Bay salt ponds. This positive relationship of bird numbers (or density) to prey density has been found for other species of waterbirds in other habitats (Yates *et al.* 1993) and in salt pans around the world, although the predictive ability of this relationship tends to be poor (Velasquez 1993; Terp 1998; Grear and Collazo 1999).

It should be emphasized that our graphs depicting the relationship between salinity and all waterbird numbers and diversity obscure important species-specific relationships with salinity. In San Francisco Bay salt ponds, fish cannot tolerate salinities much over 70-80 ppt, with salinity tolerances of most fish in the 20-40 ppt range (Carpelan 1957; Lonzarich 1989 in Harvey *et al.* 1992), so fish-eating birds tend to concentrate in ponds with mean salinities <100 ppt (Anderson 1970; Swarth *et al.* 1982). Plant-eating waterbirds (like some of the dabbling ducks) concentrate at lower salinity ponds (Accurso 1992). Thus, maintaining ponds of different salinity ranges will be critical in maintaining the widest suite of waterbird species using salt pond complexes. A consistent pattern is that at high pond salinities, where salt begins to crystallize, little, if any, invertebrate biomass is found, and fewer waterbirds use these areas (Takekawa *et al.* 2000). Aside from having no prey, birds may avoid these highest sa-

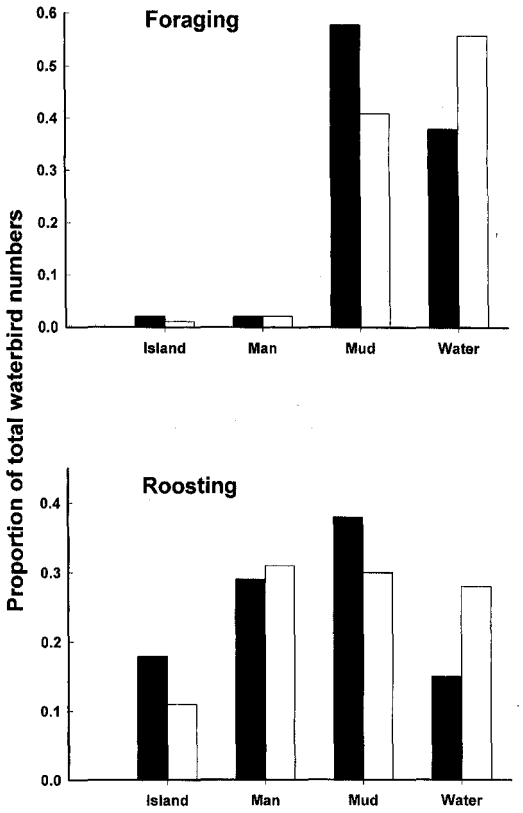

Figure 6. Proportion of waterbird use of different habitats within south San Francisco Bay salt ponds for foraging and roosting during high and low tides. Numbers combined for 1999 and 2000. Island = island of dry substrate which could not be covered by water in a strong wind; Man = man-made structure such as dikes, roads, pilings, boardwalks etc.; Mud = mudflat (dry or wet) or shallow water less than 10 cm deep; Water = open water greater than 10 cm. Dark column = high tide, white column = low tide.

linity salt ponds even for roosting because increasing water salinity negatively affects the waterproofing of waterbird feathers which increases the thermoregulatory costs to the birds (Rubega and Robinson 1997), as well as potentially having other negative effects (Purdue and Haines 1977; Euliss *et al.* 1989).

Other factors may affect numbers and diversity of birds using salt ponds. Area of ponds emerged as a significant effect in our all bird model as well as the fish-eating birds and gull models. There was a tendency for larger ponds to support larger numbers of birds and a higher diversity of species, but the predictive power of these tests was low. Accurso (1992) found different species of diving ducks preferred different size salt ponds in the Bay, but in this study, pond size was not significantly related to numbers of dabbling or diving ducks. Further research on the relationship between pond size and species number and diversity is desirable.

Swarth *et al.* (1982) noted that disturbance affected dabbling ducks in the South Bay salt ponds, causing them to use ponds farthest from points of contact with people. They attributed this wariness of the dabbling ducks to hunting. Ducks were hunted in parts of our study area and this may be the cause of some of the unexplained variation in our predictive models. Additionally, avian predators of birds, including Peregrine Falcon (*Falco peregrinus*), Merlin (*F. columbarius*), accipiters, Northern Harrier (*Circus cyaneus*), and owls were frequently observed during the course of our study. Predator attacks periodically caused birds to move to different ponds.

Habitat characteristics within ponds also affected where birds would concentrate for different activities. While we did not incorporate water depth into our predictive models due to the extreme variability in water depth of the South Bay salt ponds (PRBO, unpubl. data), it has been well demonstrated that water depth can be predictive of waterbird species (Velasquez 1992, 1993; Elphick and Oring 1998). Shorebirds generally do not feed in water at depths much greater than about 10-15 cm, and most prefer water depths under about 4 cm (Isola *et al.* 2000), except for those that swim such as the phalaropes. Dabbling ducks were often observed foraging in the same areas as shorebirds, while grebes and other diving birds typically use ponds <2m in depth (Accurso 1992; J. Takekawa unpubl. data). Over half of all the birds we observed foraging in the salt ponds were either on mudflats or in water we classified as being less than about 10 cm deep, while roosting birds made greater use of islands and dikes.

Conservation and Management Implications

During the past century, salt ponds in south San Francisco Bay have been used by great numbers and a high diversity of birds. In the breeding season, the salt ponds are

breeding habitat for a number of waterbirds (Gill 1977), including the Snowy Plover—a species protected under the U.S. Endangered Species Act (Page *et al.* 1991), the Black-necked Stilt, the American Avocet, and a number of gull and tern species (Harvey *et al.* 1992). As this study has shown, each year on high and low tides, salt ponds in San Francisco Bay are used by hundreds of thousands of waterbirds representing over 70 species. This habitat provides valuable roosting habitat to birds that have lost enormous amounts of traditional roosting sites to development around San Francisco Bay, especially super high tide, seasonal roost sites used during winter storms, similar to what has been noted for other man-made wetland types (Davidson and Evans 1986). These ponds also serve as refuges for waterbirds in a disturbance-prone urban environment (Swarth *et al.* 1982). Additionally, we have shown that this habitat provides foraging areas to many species of waterbirds that traditionally feed on tidal mudflats. This open foraging habitat may compensate, in part, for the roughly 40% of tidal mudflats lost in San Francisco Bay to landfills and dredging in the past 200 years (Goals Project 1999). Further research into what waterbirds actually gain in energetic terms from salt ponds relative to tidal marshes and mudflats would be valuable for managing for a suitable mixture of habitats.

The management implications of this study are complex yet several recommendations stand out. For attracting maximum numbers and diversity of migrating and wintering gulls and shorebirds, ponds with exposed moist soil and shallow water up to about 10 cm deep are recommended. Deeper water ponds are needed for many of the ducks and divers. Salinities of ponds need to be maintained in several ranges, especially the range where fish can live (20-60 ppt), and in the range that promotes a high biomass of invertebrate prey important to a wide range of migrating and wintering shorebirds, waterfowl, gulls, and terns. Our results suggest this latter salinity range centers around 140 ppt. Roosting waterbirds used islands in the middle of salt ponds, and maintenance and creation of island habitat should be incorporated into management plans for salt ponds. An important yet untested component of maintaining salt pond habitat for wintering and migrating waterbirds will be to prevent ponds, especially the lower salinity ponds, from becoming vegetated since many species of waterbirds, especially shorebirds, use vegetated areas, such as tidal marshes, less than open habitat (Warnock and Takekawa 1995; PRBO unpubl. data).

As has already been pointed out for San Francisco Bay (Takekawa *et al.* 2001), in order to maintain current diversity and numbers of waterbird in San Francisco Bay, conversion to tidal marsh habitat will require a greater amount of habitat than the amount of salt ponds being converted. While it is known that the salt ponds of San Francisco Bay support a large number and diversity of birds, it is not known how these birds will react if salt pond habitat is reduced. This should be the focus of major research efforts. Currently, in North America, the majority of shorebird species are thought to be in decline (Morrison 2001; Morrison and Hicklin 2001). Diving duck populations, such as scaup, have also experienced population declines (Afton and Anderson 2001). Until we get a better handle on these important conservation issues, restoring salt ponds to tidal marsh in San Francisco Bay, as is currently being proposed, should proceed with caution.

ACKNOWLEDGMENTS

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EXHIBIT 14

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
333 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94105-2197

REPLY TO
ATTENTION OF:

NOV 07 1996

Regulatory Branch (1145b)

SUBJECT: File Number 22454S

Mr. Radford (Skid) Hall Ph.D., AICP
Land Planning and Permitting Consultant
500 Airport Blvd., Suite 350
Burlingame, California 94010

Dear Dr. Hall:

Thank you for your submittal of September 26, 1996, requesting confirmation of the extent of Corps of Engineers jurisdiction at the Pond 10 - Westpoint Project site located along Westpoint Slough in Redwood City, San Mateo County, California.

Enclosed is a map showing the extent and location of Corps of Engineers jurisdiction on the Westpoint project site.

We have based this jurisdictional delineation on the current conditions of the site. A change in those conditions may also change the extent of our jurisdiction. This jurisdictional delineation will expire in five years from the date of this letter. However, if there has been a change in circumstances which effects the extent of Corps jurisdiction, a revision may be done before that date.

The Corps has reviewed your submittal for the Pond 10 - Westpoint Project dated July 1996 and conducted a site investigation on October 28, 1996. We concur with the findings of the report regarding Corps jurisdiction along the outboard side of the levees, mudflats, wetland pockets, tidal wetlands, and the northwest drainage ditch. However, we have determined, contrary to your submittal, that the interior of Pond 10 is subject to Corps jurisdiction pursuant to Section 404 of the Clean Water Act as it is an impoundment of Waters of the U.S. As stated in your report, Pond 10 is not subject to Corps jurisdiction pursuant to Section 10 of the Rivers and Harbors Act because no historic tidal sloughs are contained within this portion of the pond.

Please be advised, all proposed work and/or structures extending bayward or seaward of the line on shore reached by: (1) mean high water (MHW) in tidal waters, or (2) ordinary high water in non-tidal waters designated as navigable waters of the United States, must be authorized by the Corps of Engineers pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33

U.S.C. 403). Additionally, all work and structures proposed in unfilled portions of the interior of diked areas below former MHW must be authorized under Section 10 of the same statute.

All proposed discharges of dredged or fill material (including the movement of material associated with excavation or extraction) into waters of the United States must be authorized by the Corps of Engineers pursuant to Section 404 of the Clean Water Act (CWA) (33 U.S.C. 1344). Waters of the United States generally include tidal waters, lakes, ponds, rivers, streams (including intermittent streams), and wetlands.

Your proposed work is within our jurisdiction and a permit is required. Application for Corps authorization should be made to this office using the application form in the enclosed pamphlet. To avoid delays it is essential that you enter the file number at the top of this letter into Item No. 1. The application must include plans showing the location, extent and character of the proposed activity, prepared in accordance with the requirements contained in this pamphlet. You should note, in planning your work, that upon receipt of a properly completed application and plans, it may be necessary to advertise the proposed work by issuing a public notice for a period of 30 days.

Since an individual permit is required, it will be necessary for you to demonstrate to the Corps that your proposed fill is necessary because there are no practicable alternatives, as outlined in the U.S. Environmental Protection Agency's Section 404(b)(1) Guidelines. A copy is enclosed to aid you in preparation of this alternative analysis.

If you have any questions, please call Mark D'Avignon of our Regulatory Branch at telephone 415-977-8446. Please address correspondence to the District Engineer, Attention: Regulatory Branch, and refer to the file number at the head of this letter.

Sincerely,

ORIGINAL SIGNED
By
Calvin C. Fong

Calvin C. Fong
Chief, Regulatory Branch

Enclosures

EXHIBIT 15

APPENDIX B

Approved JD Form

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): April 21, 2008

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:San Francisco District, Napa Plant Site Restoration Project, 400258N

C. PROJECT LOCATION AND BACKGROUND INFORMATION:
State:California County/parish/borough: Napa City: American Canyon
Center coordinates of site (lat/long in degree decimal format): Lat. 38:11:31.3886° **N**, Long. 122:17:56.5830° **W**.
Universal Transverse Mercator:
Name of nearest waterbody: Napa River
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Napa River
Name of watershed or Hydrologic Unit Code (HUC):
☐ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☐ Office (Desk) Determination. Date:
☒ Field Determination. Date(s): June, 2007

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are** *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☒ Waters subject to the ebb and flow of the tide.
☒ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.
Explain: Napa Salt Plant Project contains diked off tidal waters that are below MHW, adjacent to Napa River.

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** *"waters of the U.S."* within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
      ☒ TNWs, including territorial seas
      ☒ Wetlands adjacent to TNWs
      ☐ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
      ☐ Non-RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
      ☐ Impoundments of jurisdictional waters
      ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
      Non-wetland waters: 5000linear feet: 200width (ft) and/or acres.
      Wetlands: 1460 acres.

   c. **Limits (boundaries) of jurisdiction** based on: **Established by mean (average) high waters.**
      Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional.
   Explain: .

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: **Napa River.**

   Summarize rationale supporting determination: .

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": Wetlands are contiguous to the Napa River. The project proposes to convert salt production ponds located adjacent to the Napa River back to tidal marsh.

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) **General Area Conditions:**
   Watershed size: **Pick List**
   Drainage area: **Pick List**
   Average annual rainfall: inches
   Average annual snowfall: inches

   (ii) **Physical Characteristics:**
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☐ Tributary flows through **Pick List** tributaries before entering TNW.

   Project waters are **Pick List** river miles from TNW.
   Project waters are **Pick List** river miles from RPW.
   Project waters are **Pick List** aerial (straight) miles from TNW.
   Project waters are **Pick List** aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain: .

   Identify flow route to TNW[5]: .

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

Tributary stream order, if known: .

(b) General Tributary Characteristics (check all that apply):

Tributary is:
- ☐ Natural
- ☐ Artificial (man-made). Explain: .
- ☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: feet
Average depth: feet
Average side slopes: **Pick List.**

Primary tributary substrate composition (check all that apply):
- ☐ Silts
- ☐ Sands
- ☐ Concrete
- ☐ Cobbles
- ☐ Gravel
- ☐ Muck
- ☐ Bedrock
- ☐ Vegetation. Type/% cover:
- ☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: .
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: **Pick List**
Tributary gradient (approximate average slope): %

(c) Flow:

Tributary provides for: **Pick List**
Estimate average number of flow events in review area/year: **Pick List**
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: **Pick List.** Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
- ☐ Dye (or other) test performed: .

Tributary has (check all that apply):
- ☐ Bed and banks
- ☐ OHWM[6] (check all indicators that apply):
  - ☐ clear, natural line impressed on the bank
  - ☐ changes in the character of soil
  - ☐ shelving
  - ☐ vegetation matted down, bent, or absent
  - ☐ leaf litter disturbed or washed away
  - ☐ sediment deposition
  - ☐ water staining
  - ☐ other (list):
  - ☐ the presence of litter and debris
  - ☐ destruction of terrestrial vegetation
  - ☐ the presence of wrack line
  - ☐ sediment sorting
  - ☐ scour
  - ☐ multiple observed or predicted flow events
  - ☐ abrupt change in plant community
- ☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):
- ☐ High Tide Line indicated by:
  - ☐ oil or scum line along shore objects
  - ☐ fine shell or debris deposits (foreshore)
  - ☐ physical markings/characteristics
  - ☐ tidal gauges
  - ☐ other (list):
- ☐ Mean High Water Mark indicated by:
  - ☐ survey to available datum;
  - ☐ physical markings;
  - ☐ vegetation lines/changes in vegetation types.

(iii) Chemical Characteristics:

Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: .
Identify specific pollutants, if known: .

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[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) **Biological Characteristics. Channel supports (check all that apply):**

- ☐ Riparian corridor. Characteristics (type, average width): .
- ☐ Wetland fringe. Characteristics: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

2. **Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW**

(i) **Physical Characteristics:**

(a) General Wetland Characteristics:

Properties:

Wetland size: acres

Wetland type. Explain: .

Wetland quality. Explain: .

Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:

Flow is: **Pick List**. Explain: .

Surface flow is**: Pick List**

Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .

- ☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:

- ☐ Directly abutting
- ☐ Not directly abutting
  - ☐ Discrete wetland hydrologic connection. Explain: .
  - ☐ Ecological connection. Explain: .
  - ☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **Pick List** river miles from TNW.

Project waters are **Pick List** aerial (straight) miles from TNW.

Flow is from: **Pick List.**

Estimate approximate location of wetland as within the **Pick List** floodplain.

(ii) **Chemical Characteristics:**

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .

Identify specific pollutants, if known: .

(iii) **Biological Characteristics. Wetland supports (check all that apply):**

- ☐ Riparian buffer. Characteristics (type, average width): .
- ☐ Vegetation type/percent cover. Explain: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

3. **Characteristics of all wetlands adjacent to the tributary (if any)**

All wetland(s) being considered in the cumulative analysis: **Pick List**

Approximately ( ) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)

Summarize overall biological, chemical and physical functions being performed: .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   - ☒ TNWs: linear feet width (ft), Or, 1460 acres.
   - ☒ Wetlands adjacent to TNWs: 10 acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   - ☐ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: .
   - ☐ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

3. **Non-RPWs[8] that flow directly or indirectly into TNWs.**
☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

4. **Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.**
☐ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☐ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

5. **Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.**
☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. **Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.**
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. **Impoundments of jurisdictional waters.[9]**
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☐ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]
☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

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[8]See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] **Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.***

Provide estimates for jurisdictional waters in the review area (check all that apply):
- ☐ Tributary waters: linear feet width (ft).
- ☐ Other non-wetland waters: acres.
  - Identify type(s) of waters: .
- ☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
- ☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
- ☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
  - ☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
- ☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
- ☐ Other: (explain, if not covered above): .

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
- ☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
- ☐ Lakes/ponds: acres.
- ☐ Other non-wetland waters: acres. List type of aquatic resource: .
- ☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
- ☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
- ☐ Lakes/ponds: acres.
- ☐ Other non-wetland waters: acres. List type of aquatic resource: .
- ☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
- ☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant:URS Corporation provided maps and plans.
- ☐ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  - ☐ Office concurs with data sheets/delineation report.
  - ☐ Office does not concur with data sheets/delineation report.
- ☐ Data sheets prepared by the Corps: .
- ☐ Corps navigable waters' study: .
- ☐ U.S. Geological Survey Hydrologic Atlas: .
  - ☐ USGS NHD data.
  - ☐ USGS 8 and 12 digit HUC maps.
- ☐ U.S. Geological Survey map(s). Cite scale & quad name: .
- ☐ USDA Natural Resources Conservation Service Soil Survey. Citation: .
- ☐ National wetlands inventory map(s). Cite name: .
- ☐ State/Local wetland inventory map(s): .
- ☐ FEMA/FIRM maps: .
- ☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
- ☐ Photographs: ☐ Aerial (Name & Date): .
  - or ☐ Other (Name & Date): .
- ☐ Previous determination(s). File no. and date of response letter: .
- ☐ Applicable/supporting case law: .
- ☐ Applicable/supporting scientific literature: .
- ☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD: Approximately 100 years ago tidal wetlands contiguous to the Napa River were diked off and salt production ponds were created. The salt ponds are situated below Mean High Water of the Napa River. The project proposes to breach the levee in four (4) locations arnd restore tidal action to the salt ponds to re-create tidal marsh.

EXHIBIT 16

DEPARTMENT OF THE ARMY PERMIT

PERMITTEE: Mr. Larry Wycoff, California Department of Fish and Game

PERMIT NO. 400258N

ISSUING OFFICE: San Francisco District

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate District or Division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below:

PROJECT DESCRIPTION: To breach a perimeter levee in four (4) locations and excavate a total of 417,860-cubic yards of material to create a channel at each breach location. In addition, project activities will include the discharge of a total of 169.5-acres of fill material into navigable waters and waters of the United States to raise the bottom elevation of Pond 10 to accelerate wetland vegetation colonization, to create wetland ecotone habitat transition zones, to create uplands to construct a runway safety area for the Napa County Airport, and to create uplands to re-align a site access road. The project, known as, "The Napa Site Plant Site Project," will restore tidal action to the 1460-acre project site and re-establish tidal sloughs and tidal wetlands. Project construction will be performed in two phases in accordance with the drawings titled, "Napa Plant Site Restoration Project, Planning Units and Public Access Features, Figure 3, and Figure 4", (Attachment 1). Project construction work is further described in Tables 2, 4, and 5, (Attachment 2).

The Napa Site Plant Site Project will be constructed in two phases:

PHASE I, (comprised of the North Unit and Central Unit). The following work is authorized:

--To discharge 0.9-acre of fill material (0.1-acre in wetlands) to re-align a site access road.
--To excavate tidal channels in Ponds 9, 10, W1 and W2
--To excavate a levee breach in the exterior levee at Pond 9 in the North Unit, 200-feet wide, involving 6,500-linear feet of channel excavation to remove 45,460-cubic yards of material.
--To excavate a levee breach in the exterior levee at Pond W1 in the central unit 150-feet wide, involving 2,170-linear feet of channel excavation to remove 37,400-cubic yards of material.
--To discharge 6.8-acres of fill material into Pond 10 to create uplands for the construction of a runway safety area for the Napa County Airport to mitigate the potential for bird strike hazards.
--To discharge 79.9-acres of fill material into Pond 10 to raise pond bottom to low marsh elevation to accelerate tidal wetland vegetation colonization.
--To excavate material from the interior levees between the ponds and discharge that material into the salt ponds adjacent to the interior levees to create wetland habitat transition zones.
--To sidecast all channel excavation material into the salt ponds to raise pond bottoms to low marsh elevation to accelerate tidal wetland vegetation colonization.

PHASE II, (comprised of the South Unit). **No work, and/or discharge of fill material into navigable waters and/or waters of the United States is authorized to occur in Phase II of the Napa Plant Site Restoration Project until consultation with the U.S. Fish and Wildlife Service has been completed.** Work in Phase II shall include the following:

--To excavate a levee breach in the exterior levee at Pond CB8, 660-feet wide, involving 13,000-linear feet of channel excavation to remove 287,000-cubic yards of material.
--To excavate a levee breach in the exterior levee at Pond B3, 130-feet wide, involving 2,600-linear feet of channel excavation to remove 48,000-cubic yards of material.
--To excavate material from interior levees between salt ponds and discharge that material into the ponds adjacent to the interior

levees to create wetland habitat transition zones.
--To sidecast channel excavation material into salt ponds to raise pond bottoms to low marsh elevation to accelerate tidal wetland vegetation colonization.

PROJECT LOCATION: The project is located at 2983 Green Island Road, American Canyon, Napa County, California.

GENERAL CONDITIONS:

1. The time limit for completing the work authorized ends on December 31, 2014. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activty authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions. Amendment to Order No. R2-2004-0063 adopted by the Regional Water Quality Control Board, San Francisco Bay Region, on 11 July 2007: Waste Discharge Requirements and Water Quality Certification for Napa River Salt Marsh-Lower Ponds Restoration Project.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

7. You understand and agree that, if future operations by the United States require the removal, relocation or other alteration of the structure or work authorized herein, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, you will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

SPECIAL CONDITIONS:

1. This Corps permit does not authorize you to take an endangered species. In order to legally take a listed species, you must have a separate authorization under the Endangered Species Act (ESA) (e.g., an ESA Section 10 permit or a Biological Opinion (BO) under ESA Section 7 with "incidental take" provisions with which you must comply). The enclosed U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) BOs dated September 5, 2007, and April 1, 2008 respectively contain mandatory terms and conditions to implement the reasonable and prudent measures that are associated with "incidental take" that is also specified in the BOs. NOTE: **The FWS BO dated, September 5, 2007, only covers Phase I of the project. No work, and/or discharge of fill material into navigable waters and/or waters of the United States is authorized to occur in PhaseII of the Napa Plant Site Restoration Project until consultation with FWS has been completed for Phase II.**

Your authorization under this Corps permit is conditional upon your compliance with all of the mandatory terms and conditions associated with incidental take authorized by the attached BOs, whose terms and conditions are incorporated by reference in this permit. Failure to comply with the terms and conditions associated with incidental take of the BOs, where a take of the listed species occurs, would constitute an unauthorized take and it would also constitute non-compliance with this Corps permit. The FWS and NMFS are the appropriate authorities to determine compliance with the terms and conditions of their BOs and with the ESA.

2. Levee breaching shall be restricted to a period between August 1 and October 15 when the salt ponds are typically dry.

3. Perimeter levees will be routinely inspected for erosion, excessive burrowing animal activity, and/or the presence of deep-rooted woody plants. Levee crown maintenance will be conducted if problems are identified.

4. The permittee shall apply appropriate best management practices, including stabilizing and seeding disturbed upland slopes, to avoid, control, and minimize erosion, sediment input, and turbidity into the water column.

FURTHER INFORMATION:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

   (X) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. Section 403).
   (X) Section 404 of the Clean Water Act (33 U.S.C. Section 1344).
   ( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. Section 1413).

2. Limits of this authorization:

   a. This permit does not obviate the need to obtain other Federal, State, or local authorizations required by law.

   b. This permit does not grant any property rights or exclusive privileges.

   c. This permit does not authorize any injury to the property or rights of others.

   d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability: In issuing this permit, the Federal Government does not assume any liability for the following:

   a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

   b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

   c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

   d. Design or construction deficiencies associated with the permitted work.

   e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision: This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate. (See Item 4 above.)

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 C.F.R. Section 325.7 or enforcement procedures such as those contained in 33 C.F.R. Sections 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 C.F.R. Section 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions: General Condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

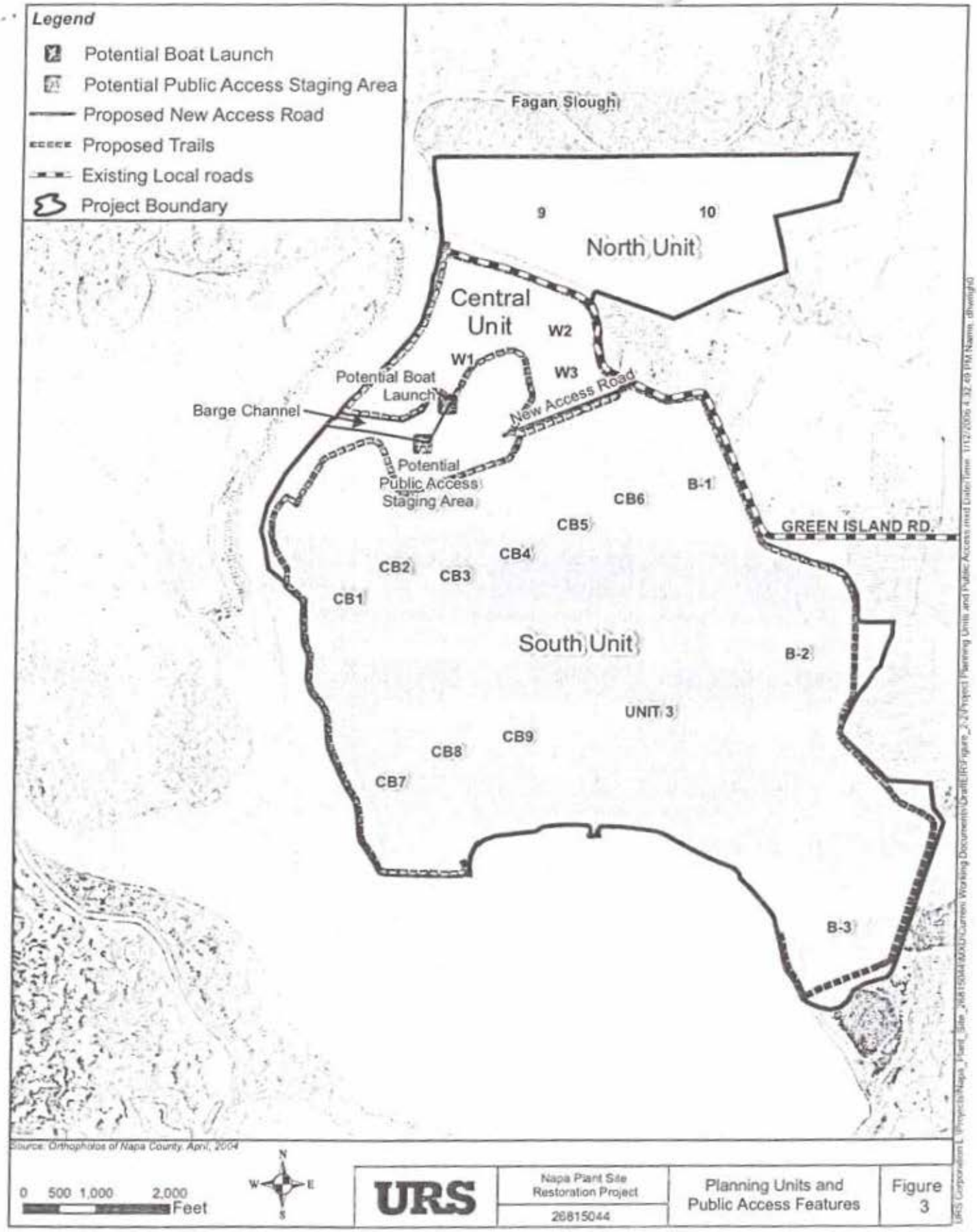
(PERMITTEE) Charles Armor — May 9, 2008 (DATE)
Regional Manager
Department of Fish and Game

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Craig W. Kiley — 5/13/08 (DATE)
Lieutenant Colonel, U.S. Army
Commanding

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) _____ (DATE) _____


Legend
Potential Boat Launch
Potential Public Access Staging Area
Proposed New Access Road
Proposed Trails
Existing Local roads
Project Boundary
Fagan Slough
9
10
North Unit
Central Unit
W1
W2
W3
Potential Boat Launch
Barge Channel
New Access Road
Potential Public Access Staging Area
B-1
CB6
CB5
GREEN ISLAND RD.
CB4
CB2
CB3
CB1
South Unit
B-2
UNIT 3
CB9
CB8
CB7
B-3
Source: Orthophotos of Napa County, April, 2004
0 500 1,000 2,000 Feet
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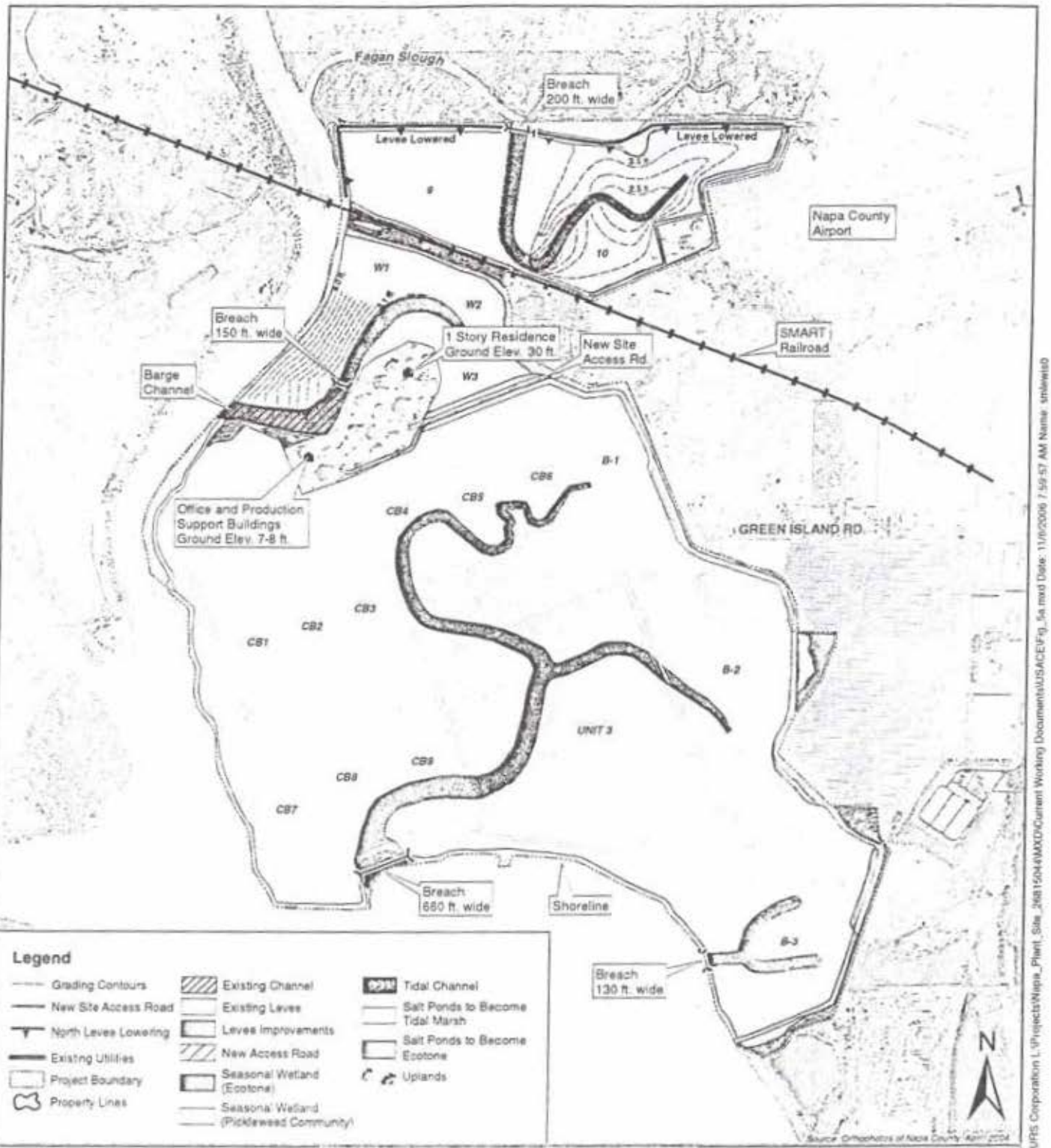
Napa Plant Site Restoration Project
26815044
Planning Units and Public Access Features
Figure 3



PURPOSE: WETLAND RESTORATION

DATUM: NAVD88

ADJACENT PROPERTY OWNERS: SEE TABLE 5 OF USACE PERMIT APPLICATION

PLAN VIEW

0 500 1,000 2,000 3,000

1 inch equals 1,750 feet

CALIFORNIA DEPARTMENT OF FISH AND GAME

FIGURE 4
PROPOSED PROJECT

IN: CITY OF AMERICAN CANYON
AT: 2983 GREEN ISLAND RD.
COUNTY OF: NAPA STATE: CA

APPLICATION BY: CALIFORNIA DEPARTMENT OF FISH AND GAME

DATE: 11/10/06

UFS Corporation L:\Projects\Napa_Plant_Site_2681504\MXD\Current Working Documents\USACEFig_5a.mxd Date: 11/6/2006 7:59:57 AM Name: sniewiadomski

Table 2
Dimensions of Levee Breaches and Tidal Excavation

Restoration Unit	Bottom Width of Breach (Feet)	Channel Excavation[a,b] (Linear Feet/cubic yards)	Associated Drainage Area (Acres)
North Unit	200	6,500/45,460	167
Central Unit	150	2,170/37,400	94
South Unit (CB 8 Breach)	660'	13,000/287,000	700
South Unit (Pond B-3 Breach)	130'	2,600/48,000	146

[a] Breach widths and channel excavation are based on preliminary calculations and modeling, and are estimates of the maximum that would be required for restoring tidal circulation. The actual breach dimensions and channel excavation volumes will be determined in further hydrodynamic analysis and detailed design of the proposed project.

[b] Volumes do not include breach excavation

Table 4
Surface Area of Wetlands and Non-wetland Waters to be Filled

Activity	Fill in Wetlands	Fill in Waters	Total Fill	Area converted to uplands
	(acres)			
Raise elevation of Pond 10	0	79.9	79.9	0
Ecotone habitat transitions	0	13.2	13.2	0
Sidecast of channel excavation material	0	68.8	68.8	0
Runway Safety Area (RSA)	0	6.8	6.8	6.8
Realigned access road	0.1	0.8	0.9	0.9
Total	0.10	169.5	169.6	7.7

Table 5	Wetlands (acres)	Waters (acres)	Total Jurisdictional Area (acres)	Upland (acres)	Total Site (acres)
Pre-project condition	8.8	1,237.40	1,246.20	213.8	1460
Post construction	1236	99	1335	125.00	1460

EXHIBIT 17

US Army Corps of Engineers

Regulatory Branch
1455 Market Street
San Francisco, CA 94103-1398

SAN FRANCISCO DISTRICT

PUBLIC NOTICE

Project: Phase I – South Bay Salt Pond Restoration Project

NUMBER: 27703S DATE: 1/15/08 RESPONSE REQUIRED BY: 2/15/08
PROJECT MANAGER: Paula C. Gill PHONE: (415) 503-6776

1. **INTRODUCTION:**

Subject: The California Department of Fish and Game, Region 3 (7329 Silverado Trail, Napa, California, 94599) and the U.S. Fish and Wildlife Service (Don Edwards San Francisco Bay Wildlife Refuge, 9500 Thornton Ave., Newark, California, 94560) have applied for a Department of the Army permit to conduct work within the Corps' jurisdiction to implement Phase I of the South Bay Salt Pond (SBSP) Restoration Project. Phase I involves discharge of fill within former salt ponds located at the Ravenswood (SF2), Alviso (A5, A6, A7, A8, A16, & A17) and Eden Landing Ponds (E8, E9, E12, and E13). The approximately 4,155 acres of salt ponds are located in San Mateo, Santa Clara, and Alameda Counties (see Figure 1).

Authority: This application is being processed pursuant to the provisions of Section 404 of the Clean Water Act (33 U.S.C. Section 1344) and Section 10 of the Rivers and Harbors Act (33 U.S.C. 403).

2. **PROPOSED PROJECT:**

Project Purpose: The objectives of Phase I of the SBSP Restoration Project are to restore and enhance a mix of wetland habitats and to provide wildlife-oriented public access and recreation in the South San Francisco Bay.

Project Description: A permit for Phase I of the SBSP Restoration project would authorize actions involving tidal habitat restoration, pond reconfiguration and recreation / public access actions, as well as monitoring activities, and applied studies. Ultimately, the larger SBSP Restoration project would provide for a mix of restored tidal and managed pond habitats. The tidal habitat would include salt and brackish marsh, mudflats, subtidal flats and channels, marsh ecotones and upland transitional zones, salt pannes and ponds, and sloughs. Managed pond habitats would include pond reconfiguration and water regime management that would be used to enhance and create ponds with a variety of depths and salinities and associated levee and islands. Phase I would be the first step towards restoration of 15,100 acres of commercial salt ponds purchased from Cargill Salt in March 2003 to a mix of tidal wetlands and other habitats using state, federal, and private foundation funds.

Phase I actions are specific to Ponds A6, A8, A16, SF2, E8A/E8X/E9 and E12/E13 and are required for subsequent SBSP restoration activities. No specific flood management actions (e.g., flood control levees) are proposed in Phase I of the project, although Phase I ponds were chosen because they do not, in and of themselves, require the implementation of flood control measures.

Habitat Restoration Component (tidal restoration and managed ponds): In and around ponds A6, A8, A16, SF2, E8A/E8X/E9, and E12/E13, the proposed work would include breaching and lowering sections of levees, excavation of pilot channels, constructing ditch blocks to fill borrow ditches, enlarging channels, removing or adding water control structures, and the placement of fill (see Figures 2-13) for improved wildlife habitat.

Public Access and Recreation Component: The proposed public access and recreation activities include upgrades to trails, the construction of viewing platforms and interpretative stations (see Figures 9, 13), and a kayak/boat launch. In addition, American Disabilities Act compliant features would be installed as funding allowed.

IMPACTS:

The project would require 609,093 cubic yards of fill with a total excavation footprint of approximately 383 acres (with additional temporary impacts of 40.55 acres). The majority of the material removed as part of the excavation activities would be reused on-site as fill specifically for restoration actions. Totaling all fill and excavation work would result in redistribution of approximately 1,217,436 cubic yards effecting 789.15 acres of Waters of the U.S. Additionally, redistribution of approximately 750 cubic yards of fill would result in effects to 31.2 acres of wetlands.

After implementation of restoration actions, indirect impacts to waters of the U.S. resulting from scour of existing outboard marshes could occur along Mt. Eden Creek, North Creek, Old Alameda Creek, Alameda Creek Flood Control Channel, Mud Slough, Coyote Creek, Alviso Slough, Guadalupe Slough, Stevens Creek, Mountain View Slough, Charleston Slough, and Ravenswood Slough which may total up to approximately 100 acres.

PROPOSED MITIGATION:

Due to the anticipated development of marsh habitats within tidal restoration ponds (E9/E8A/E8X, A6 and reversibly, A8/A8S) resulting from the proposed activities and continued use of Ponds E12/E13, A16, and SF2 as managed ponds for wildlife, there would be no mitigation measures required with the exception of measures taken to minimize or avoid disturbance to sensitive habitat areas. A total of 1,060 to 1,460 acres of tidal marsh habitats would be anticipated to develop within the Phase I ponds if tidal action is restored. Intertidal mudflats would comprise the majority of pond interiors up to year ten (10), with vegetated middle marsh developing as a dominate habitat thereafter. Overall evolution of restored ponds to tidal marsh would occur over 10 to 30 years.

3. **COMPLIANCE WITH VARIOUS FEDERAL LAWS:**

National Environmental Policy Act of 1969 (NEPA): In accordance with the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) an EIR and EIS were prepared and released for the entire 15,100-acre SBSP project. This evaluation includes review of the proposed Phase I actions.

The EIS and EIR are currently in review by the lead agency. Comments have been received and are being considered. The Record of Decision is anticipated to be received in early 2008.

The EIS and EIR focus on key issues, including hydrology, water quality, biological resources, and geology and soils. Other resource topics such as air quality, hazardous materials, noise, land use, recreation, and cultural resources were also addressed. Two habitat restoration options were evaluated in the EIR and EIS in addition to evaluation of the no-project alternative.

Endangered Species Act of 1973 (ESA): Section 7 of the Endangered Species Act requires formal consultation with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) if a Corps permitted project may adversely affect any federally listed species or their designated critical habitat.

Several listed species are known from the SBSP Phase I Project vicinity, including seven federally listed species including: salt marsh harvest mouse (*Reithrodontomys raviventris*), California clapper rail (*Rallus longirostris obsoletus*), western snowy plover (*Charadrius alexandrinus nivosus*), California least tern (*Sterna antillarum browni*), California brown pelican (*Pelecanus occidentalis californicus*), central California coast steelhead (*Oncorhynchus mykiss*), and its Critical Habitat, and green sturgeon (*Acipenser medirostri*s).

A Biological Assessment (BA) was compiled and submitted to the USFWS and NMFS in June of 2007. Separate BA's for Phase I actions were submitted in July and August of 2007. Section 7 Consultation under the Federal Endangered Species Act is currently in progress and the issuance of Biological Opinions from both agencies are pending.

Magnuson-Stevens Fisheries Conservation and Management Act: Essential Fish Habitat - The Magnuson-Stevens Fishery Conservation and Management Act requires all Federal agencies to consult with the NMFS on all actions, or proposed actions permitted by the agency that may adversely affect Essential Fish Habitat (EFH).

A Biological Assessment addressing Project effects on EFH associated with the Coastal Pelagics, Pacific Groundfish, and Pacific Coast Salmon Fisheries Management Plans was prepared and submitted to NMFS in July of 2007. The NMFS' EFH conservation recommendations are pending.

Clean Water Act of 1972 (CWA):

a. Water Quality: Under Section 401 of the Clean Water Act (33 U.S.C. Section 1341), an applicant for a Corps permit must first obtain a State water quality certification before a Corps permit may be issued. No Corps permit will be granted until the applicant obtains the required water quality certification. The Corps may assume a waiver of water quality certification if the State fails or refuses to act on a valid request for certification within 60 days after the receipt of a valid request, unless the District Engineer determines a shorter or longer period is reasonable for the State to act.

Those parties concerned with any water quality issue that may be associated with this project should write to the Executive Officer, California Regional Water Quality Control Board, San Francisco Bay Region, 1515 Clay Street, Suite 1400, Oakland, California 94612 by the close of the comment period of this Public Notice.

b. Alternatives: Evaluation of this proposed activity's impact includes application of the guidelines promulgated by the Administrator of the Environmental Protection Agency under Section 404(b)(1) of the Clean Water Act (33 U.S.C. Section 1344(b)). A 404(b)(1) alternatives analysis has been prepared by the Applicant and is available on file with this office. For the Project, the basic project purpose is to restore tidal habitat and maintain pond habitats using methods and approaches with a high potential for success. The basic purpose is therefore water dependent; implementation of restoration efforts does require access or proximity to a special aquatic site.

Habitat Restoration (tidal restoration and reconfigured ponds): The actions required for the Phase I of the project have been designed to require the least fill placement within Corps' jurisdiction possible while still attaining project goals. All proposed impacts (e.g., fill placement to create nesting islands) are to create or enhance habitat for listed species and other birds, and to optimize restoration activities; environmental benefits will result from implementation of restoration.

Public Access and Recreation Component: After considering the goals and objectives of this part of the project and site constraints and opportunities, it was concluded that the work related to public access and recreation (e.g., trails, viewing platforms, interpretative stations, and kayak launch) can only be completed in the chosen locations to minimize impacts to Corps' jurisdiction. These features are primarily located on existing levees, with no impacts to wetland habitat. Alternative sites would require additional discharge of fill into Waters of the U.S.

Coastal Zone Management Act of 1972 (CZMA): Section 307 of the Coastal Zone Management Act requires the applicant to certify that the proposed project is consistent with the State's Coastal Zone Management Program, if applicable. No Corps permit will be issued until the State has concurred with the applicant's certification. Concurrent with this application, materials have been forwarded to the San Francisco Bay Conservation and Development Commission (BCDC). Questions related to that application should be forwarded to BCDC, 50 California Street, Suite 2600, San Francisco California 94111.

National Historic Preservation Act of 1966 (NHPA): The EIS and EIR for the larger SBSP Restoration Project addressed potential impacts of all of the sets of options to cultural resources. Mitigation measures were outlined for those impacts that would result in an adverse effect to cultural resources. Consultation with the State Historic Preservation Office (SHPO) and appropriate Native American Tribes in accordance with Section 106 of the National Historic Preservation Act is pending.

4. **PUBLIC INTEREST EVALUATION:** The decision whether to issue a permit will be based on an evaluation of the probable impact, including cumulative impact, of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits that reasonably may be expected to accrue from the proposed activity must be balanced against its reasonably foreseeable detriments. All factors that may be relevant to the proposal will be considered, including its cumulative effects. Among those factors are: conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people.

5. **CONSIDERATION OF COMMENTS:** The Corps of Engineers is soliciting comments from the public, Federal, State and local agencies and officials, Indian Tribes, and other interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps to determine whether to issue, condition or deny a permit for this proposal. To make this decision, comments are used to assess impacts on federally listed species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in the preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act. Comments are also used to determine the need for a public hearing and to determine the overall public interest in the proposed activity.

6. **SUBMISSION OF COMMENTS:** Interested parties may submit, in writing, any comments concerning this activity. Comments should include the applicant's name and the number and the date of this Public Notice, and should be forwarded so as to reach this office within the comment period specified on Page 1.

Comments should be sent to the U.S. Army Corps of Engineers, San Francisco District, Regulatory Branch, 1455 Market Street, San Francisco, California 94103-1398. It is the Corps' policy to forward any such comments that include objections to the applicant for resolution or rebuttal. Any person may also request, in writing, within the comment period of this Public Notice that a public hearing be held to consider this application. Requests for public hearings shall state, with particularity, the reasons for holding a public hearing. Additional details may be obtained by contacting the applicant whose name and address are indicated in the first paragraph of this Public Notice or by contacting Paula Gill of our office at telephone 415-503-6776 or E-mail: Paula.C.Gill@usace.army.mil. Details on any changes of a minor nature that are made in the final permit action will be provided upon request.